THE

TRACKMAN'S HELPER

SECOND EDITION,

Revised and Enlarged, Nearly 100 Pages Added, With New Illustrations and Tables.

A Pocket Companion

FOR

Track Foremen Generally.

It Treats on More than

300 Different Subjects

Relating to Track Work, with Rules, Tables and Illustrations.

AS A BOOK OF REFERENCE FOR SECTION FOREMEN IS

Superior to any Book Heretofore Published.

BY

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Mitchell, - - South Dakota.

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Yours Truly
J. Kindelan

PREFACE.

I can no better introduce the Second Edition of the Track Man's Helper to the reader, than with the opening lines of my first preface.

The main object of the author in writing this book is, through its agency, to assist young or inexperienced men who work on track repairs or construction, to become the equals of track foremen who have had more experience and a wider field to work in, and thereby make the track service more efficient, and save roadmasters and other officers from the necessity of continually instructing inexperienced men on every subject relating to track work.

That there is a necessity existing, for such a book is admitted by every good trackmen, and I have received many letters from prominent trackmen, and other railroad officers throughout the United States, who all agree in the opinion ex-

pressed, that all trackmen should be supplied with a book of instructions, which would advance their knowledge of theoretical and practical details of construction and track maintenance quicker than such knowledge can be gained by actual experience. This would fit them for doing all work in a practical manner, with less inconvenience to themselves and in a way that would be more satisfactory to the company by preventing waste or loss which is common when the men are ignorant of their duties. The time of roadmasters, supervisors, and others, is often so fully taken up with other duties that they seldom have time or opportunity to give full instructions to *all* the men working under them in a manner that would insure their thorough efficiency as good reliable trackmen.

Of course, after a certain amount of time has elapsed since a man has entered the service, his natural aptitude for gathering knowledge along with what instructions he receives, will make him a good average trackman, and familiarize him with the rules of the road and his other duties, but unless he has had the benefit of a wide field of experience and a very thorough training, he seldom becomes so expert as to be able to do in a proper manner many kinds of work with which he is unacquainted, but which he may be called upon to do at any time.

To help fill this want of the trackman, the writer published the first edition of this book,

which I hope has proved to be what its name indicates, a helper for trackmen.

I fully realized how difficult a task it would be to write a book which would be accepted by even a majority of the trackmen of the country, but to accomplish anything, a beginning must be made, and as I had a practical education, from the shovel up, I thought I could offer something that would at least assist the ambitious young trackman seeking knowledge of his profession. I deemed it my duty also to put into book form what little of practical knowledge I possessed, if for no other reasons, than to show the importance of the track, in relation to the other railroad departments, and assist in bringing more uniformity into the methods of doing track work on the different railroads.

The book was not without its share of errors and shortcomings, but it has been well received by the trackmen of the country. In fact, it had a much better reception than the writer had anticipated, and the many letters I have received from railway officers and roadmasters, commenting favorably on the work, have encouraged me to publish this Second Edition and to add to the old work as much valuable matter as was possible, which would be consistent with present day practice.

Before closing I wish to make a few remarks about the practical training of trackmen. It is of the greatest importance that railroad compan-

ies employ none but the best and most expert trackmen for roadmasters, supervisors or foremen, because on these men depends in a great measure the successful operation of the road. The track and roadway being the most important and costly department to maintain, it offers superior advantages for these men to display what talents they possess in economically keeping up a first class track, and educating the laborers to perform their duties in a thorough, practical manner without waste or loss to the company, and with the greatest degree of safety to the trainmen and the public.

I believe the best way to produce good, practical trackmen, is by educating them along with what knowledge they possess, or have gathered from experience, and I believe the best aid to accomplish this end would be the distribution amongst the men of instructions in book form, covering all the theoretical and practical details of their work according to the best methods now in practice. This would cost the companies but a small amount separately and the results would repay them many fold.

The history of track maintenance from the beginning up to the present date, shows a state of affairs existing which would not be tolerated in any other business. With only a few exceptions, little if any effort has ever been made by the railroad companies to aid their men to gain a technical as well as a practical knowledge of

their profession; in fact an entirely opposite course has been pursued in most cases.

The civil engineers and such officers as have charge of the laying out, or direction of construction work, have been too widely separated from those in charge of the practical end of the work, and as a consequence, the trackman has to shift for himself and pick up his knowledge by a slow and tedious process, which often results in great injury to the company which employs him; and it very often happens that the men who hold a superior position above him, know so little about the details of his work that they are not qualified to correct his errors. It cannot be denied that to construct and properly maintain a first class track, is both a science and a trade that requires its share of energy, skill, intelligence and ability in just as great a degree as any other important profession; but owing to the rapidity with which new construction has been carried on in this country, together with the very limited opportunities which some trackmen have for gaining a thorough knowledge of their business there are many now working on railroads who could not be numbered in the first class. It would be well, I think, if the different railroad companies attached more importance to the necessity which exists for adopting some system of educating their trackmen to a higher standard of excellence.

If by the publication of this book I have laid

one more stone in the arch which would span the gulf of prejudice and support all good trackmen in a common effort for the welfare of each other, and the upbuilding of their profession, I have accomplished enough, and I sincerely hope that what little I have added to the track literature now in existence may only be the beginning of something better and more worthy.

Yours Truly, J. KINDELAN.

In the preparation of this Second Editon of the Trackman's Helper, I have been ably aided by Mr. H. W. Seib, C. E. of Clarence, New York; and also assisted by Mr. T. H. Curtis, C. E. of New Haven, Connecticut and Mr. D. Sweeney, R. M. of C. K. & N. R. R. Bellville, Kansas.

J. K.

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NEW ROAD.

CHAPTER I.

1. A good railroad should be complete in all respects; track should be full bolted, full spiked, well ballasted, surfaced, lined, and guaged, and nothing omitted in its construction which would contribute toward making it a perfect and safe track. A poor track no more deserves to be called a railroad than a shanty does to be called a house, and track men who are in the habit of

doing poor work with the means at hand to do better, never learn how to do good work.

TRACK LAYING.

2. The best dirt ballasted track can be made when laying it, by bedding the ties to a level surface on top before putting on the rails. To lay track this way, the company's engineers must first set level stakes by which to bed the ties, and these stakes should be close enough together for a sixteen foot straight edge to reach from one stake to the next. To have the engineer set level stakes so close together that a straight edge will reach from one stake to the other is contrary to the common practice, but it is a much better way in so much that the increased labor of the engineer is fully compensated for in having the whole tie bedding gang under the control of one foreman. This method also does away with the necessity of using sight boards and dividing up the men to sight in the lead ties between level stakes fifty or one hundred feet apart. The work is also more accurate when finished, if the straight edge can reach a level given with the engineer's instrument, than it would be, if the levels were sighted in by the average track laborer.

TRACK LAYING MACHINES.

3. Track laying machines have been used to

some extent when building extensions on some of the railroads. When track is laid with them the ties and rails are run out along the material cars to the front, on rollers in some cases and in others an endless belt carries out the material along the sides of the cars. Only one or two rails of track are laid at a time, and partly spiked, then the train moves up and the same operation is performed again. Economy in the force of men necessary to lay track with these machines, together with the saving effected by not having to haul the ties by team to the front, are the chief claims put forward in their favor. But the amount of track laid each day must always be limited to what can be bolted and spiked safe for trains between the forward moves of the machine, seldom exceeding a mile and a half in a day, and oftener one third less. In a good country to lay track where ties can be hauled ahead by team, and men are plenty, much better results can be obtained without track laying machines, if it is desired to rush the track laying.

HAVE TOOLS READY.

4. Every good track man knows the tools which his men should use, and before starting out to lay track on a new road the boss track layer should make requisition for all the necessary tools. These tools should all be loaded into a car and shipped direct to the point where work is to be commenced. Every thing should

be in readiness to make a good beginning, before the men are brought upon the ground. Many awkward and serious delays have been caused by the foreman in charge neglecting to see to the arrangements in time for working his men properly.

TRACK LAYING TOOLS AND MATERIAL.

5. Hand cars	1
Steel cars	3
Push cars	2
Shovels, R. R.	150
Picks	50
Lining Bars	12
Claw Bars	12
Tamping bars	12
Nipping bars	24
Cold chisels	24
Rail punches	6
Chopping axes	6
Hand axes	6
Spiking hammers	42
Bush scyths and snaths, each	3
Hand saws	6
Adzes	6
Track guages	12
Spirit levels	6
Tape lines	6
Nail hammers	3
Monkey wrenches	3
Lanterns, red	3
Lanterns, white	3
Water pails	6
Tin dippers	6
Oil cans	2
Oilers	3
Gallons of oil	2
Nails	1 keg 10 penny
Nails	1 keg 20, 40, 60
Pick handles	24
Adze handles	6
Axe handles	6
Maul handles	36
Red flags	12
Sledges, 16 lbs. each	3
Grind stones	1
Track wrenches	24
Iron tongs, pairs	3
Rail forks	6
Expansion shims	200
Switch locks	6
Rail drills	2
Torpedoes	4 dozen
Track jacks	4
Rail benders	2
Covered water barrels	2
Track levers	2
Chalk lines	2
Files	6
Crosscut saws	2
Curving hooks	2
Post hole diggers	2
1¼ inch rope	300 feet
Tie poles, 30 feet long	2
Tie line, 1,000 feet long	1
Set double harness	1
Set single harness	1
Set double and single trees	1
Wagons	1
Scrapers	1
Horses or Mules	2
Tool boxes	2

The above list of tools will do to supply an average gang of 100 track layers with a surplus to

equip extra men if required, or replace tools out of repair or broken, until supplies ordered can be got to the front. The accomodations for track laying should be about as follows:

One supply and office car.

One kitchen car.

Two dining cars.

Three sleeping cars.

Where track laying is done at a long distance from the base of supplies a blacksmith with forge and tools should accompany the outfit.

TIE BEDDING.

6. The work of tie bedding consists in placing a straight edge in a level position over the top of loose ties lying on the grade, and bringing up each tie to a uniform surface under the straight edge, just as it should lie in track under the rails. Thin ties should have dirt or ballast thrown under them and be settled to the correct level. The bed under thick ties should be dug out and the dirt removed sufficiently to bring the tie down to the level of the other ties. One straight edge should be provided for every two men of the tie bedding gang. If there are plenty of men in the tie bedding crew they can do most of the filling between the ties, this part of the work receiving attention in proportion to the speed with which the rails are laid. The surfacing crew gives the finishing touches after the track

is laid. If the tie bedding is done properly, the track will be in good condition every night for trains to run over it, as far as it is finished, without any danger of injuring the rails, and a much smaller crew is required to surface behind the track layers. When it is intended to ballast the track with dirt from the embankment, the ties should always be bedded before laying the rails, for the reason that the grade is seldom or never a smooth surface to receive the ties; moreover, the ties, no matter how well selected, are of different thickness, and it is well known that light iron or steel rails, laid on loose ties on a poor grade, will be kinked and damaged considerably by trains running over the track before it is surfaced up smooth and level. Another good point in favor of tie bedding is that the rails can be laid much faster than over loose ties, and the spiking can be done better and with less labor.

OMIT THE TIE BEDDING.

7. If it is intended to ballast track with cinders, gravel or stone, as fast as it is laid, the tie bedding should be omitted in order to have the full width of the grade to deposit the ballast upon, but at the same time the ballasting should be kept finished up close behind the track layers to obivate the danger of spoiling rails.

Very few trackmen realize the necessity or make much effort to protect the rails from be-

ing kinked or surface bent, when laying track, and a large part of new track throughout the United States bears evidence of their carelessness.

All railroad companies are more liberal when constructing than they are when the road is in operation, and if a company lays their own track the man in charge of the work should see that it is done well, even if the cost is greater. It pays in the end. When the work of constructing a railroad is poorly done it is never finished afterwards.

GOOD MEN AT THE FRONT.

8. When building new road the man in charge of the track laying should endeavor to secure good sober men to work at spiking and laying the rails, because on the front men in a great measure depends the amount of track laid every day. The spikers and iron men should be paid better wages than the other men, not alone on account of the work, but to encourage them to do their best, and also, that you may readily secure picked men to fill their places whenever needed. All the men at track laying should be well organized; each man should have his particular work to perform. The men should not be allowed to work promiscuously, changing from one place to another. One foreman should have charge of the iron men, another of the

spikers, and a third of the surfacing crew, all subject to the boss track layer. It is poor economy to try to lay track without any of the three foremen mentioned, as is sometimes done, because, although a good track layer may be able to oversee a considerable number of men, he cannot look after the details of the work in its different branches, and give it the required attention, without the assistance of these foremen except where the work is done with a small gang of men.

A SURFACING GANG.

When laying track it is always best to keep at least a small surfacing crew behind to recruit from, if you are short of men at the front and any extra men at the front should be put to surfacing.

The amount of supplies taken out each day should be in proportion to the number of men you are working, and only enough should be taken out at one time for a good half day's work, because much more than that amount would only be in the way and delay the work. Where the ties for a new track are hauled out along the grade by teams it is always best to let the work out by contract. This will save the necessity of hiring and watching the teamsters and insure the work being done without delay.

LOCATING JOINT TIES.

9. Every tracklayer should have two men to carry a measuring pole the correct length of a rail for locating the joint ties, ahead of the rails. These men should also space the ties on each side of the joint wherever necessary. They could also adze twisted ties and bed down ties which were too high. The joint ties should not be located very far ahead of the rails, because there is liable to be variation in the distances, and the measurements taken with the pole should be corrected from the end of the rails occasionally. The track laying is delayed and the ties are seldom as well spaced when this work is left to the spikers.

LAYING THE RAILS.

10. A construction foreman should see that no new rails be laid in a new track before all kinks and crooked places in the rails are straightened. It is a common fault of track foremen when in a hurry to throw down all iron or steel just as it comes to the front, regardless of any kinks that may have been put in the rails while in transit, or in dumping them off cars. Many light weight rails are irreparably damaged in this way, and after such rails are put in a track they are seldom, if ever, made perfect again, as

section foremen very seldom have the necessary amount of help, or spare time to do what could have been done in a very short time before the rails were laid.

EXPANSION AND CONTRACTION.

11. Track foremen, when laying iron or steel rails, should be very particular to give the proper space at the joints for expansion. Avoid leaving the joints too close in cold weather, or too much open in warm weather, either of which causes much trouble afterwards.

As soon as the weather becomes warm, rails which were laid in the track with very close joints, during colder weather, begin to expand and increase in length, as the heat increases, until the opening between the ends of the rails is entirely closed. After this, as there is no further room for expansion, the track is forced out of line, and kinks are put in the shoulder of light weight rails. This extreme expansion is very dangerous for fast trains, and in many cases has been the cause of wrecks. The effect of expansion of the rails is most noticable on the line of track which is only partially ballasted and filled between the ties, or where track has been laid down without any particular ballast.

HEAT AND COLD.

12. Contraction is a shrinking or shortening up of the rails, and is caused by cold weather. The contraction of the rails increases with the severity of the cold, and by this process, the opening in the joint between the rails is enlarged.

Sometimes in the winter the contraction is so great that where the rails were not properly laid the track is torn apart, joint splices are broken, and openings between the rails are increased from three inches to a foot, rendering the track extremely dangerous for trains, unless discovered in time by the trackmen and repaired.

Too much space at the joints also affects the wearing qualities of the rails, the opening at the joint being so large that the car wheels batter their ends, and they wear out and have to be taken out of service much sooner than rails of the same quality if laid with the proper spacing on another part of the road.

EXPANSION TABLE.

The following table shows the proper space to leave between the ends of the rails when laying track at any temperature:

TEMPERATURE.	AMOUNT OF EXPANSION.
At 90 degrees above zero......	1-16 of an inch.

At 70	"	"	"	1-8	"	"	"
At 50	"	"	"	3-16	"	"	"
At 30	"	"	"	1-4	"	"	"
At 10	"	"	"	5-16	"	"	"
At 10	"	below	"	3-8	"	"	"

With slight variations this table will do for any weight of rails now made.

Expansion shims should be made of narrow flat iron or steel, and bent so that one end would rest on top of the rail when in place. The shim could thus be easily removed and used again, after a piece of track was laid, and all the bolts then tightened up on the joint fastenings.

A ten-penny common steel nail, if bent at right angles, makes a cheap and handy expansion shim when no others are provided. It may be used at almost any temperature above the freezing point, by reversing the end and flattening the head of the nail. Expansion shims should not be allowed to remain between the ends of the rails after a piece of track is laid and the joint fastenings have been made secure.

Care should be taken when laying old iron or steel rails, to make the same allowance for expansion as when laying new rails.

TRANSFERRING MATERIAL.

13. Owing to the scarcity of flat cars on railroads, box cars or stock cars are often used to ship rails to the front when track laying. All

rails which come in this manner have to be transferred to flat cars at certain points, in order to facilitate handling them before laying at the front. The transfer of rails from box or stock cars can best be accomplished by switching empty flat cars between the loaded cars and attaching framed rollers to the end doors of the loaded cars to run the rails out upon. A hollow iron roller can also be used to place under the rail within the loaded car, and one upon the flat car where it receives the rail. If this is done a large quantity of rails can be transferred in a day with a small crew of men. The transfer foreman should keep posted as to the quantity and different kinds of material wanted at the front, and he should make every effort to forward the supplies so as not to delay the track laying. He should also keep an accurate and detailed account of all track material, or other supplies which passes through his hands.

MIXED LENGTHS OF RAILS.

14. When it is possible to avoid it mixed lengths of rails should not be used when laying track. The cost of repairing such a track is always greater than a track laid with rails of a uniform length, and when the rails begin to wear out there is a large amount of material wasted and time lost by replacing the battered rails from rails of a different length for repairing. When

track layers find it necessary to get rid of a mixed lot of rails, the best place to lay them is in a side track, matching all rails of an equal length or height. When there is not room for mixed rails in side tracks, lay them in the main track close to or at a station; there the track is safer, and the section man can do the necessary repairing or changing of rails at less cost, and to better advantage than out on his section.

A SHORT RAIL FOR CURVES.

15. When laying rails around a curve, a foreman should have on hand a few 29 foot or 29½ foot rails, and put one in on the inside of the curve whenever it is necessary to square the joints, as the inside rail will gain on the outside rail in proportion to the degree of the curve.

A TIE UNDER JOINTS.

16. Wherever a rail joint comes in a track, no matter how short the piece of rail, or how long, there should always be a tie under that joint to support it. Suspended joints are knocked down out of surface easier than those supported by ties, and are often the cause of broken rails, because there is so much spring in the suspended end of rails where splices get loose. Where angle bar splices are used, and where it

is possible, and the splices are long enough, a tie should be placed under the center of the joint. All the short angle bar splices now in use on railroads will bend down with the joint and break, unless well taken care of and kept up to proper surface and the bolts tightened when they become loose.

THE 46-INCH ANGLE BAR SPLICE.

The 46-inch angle bar splice, bolted properly with bolts, elastic or spring nut locks, and spiked solidly through the slots in the splice to the track ties, presents at the present day the best practicable connection and support for the joint yet invented, and it will allow expansion and contraction of the rails, and prevent creeping, if the rails are laid with the proper spacing at all places. Spiking in a slot at the end of the rail flange does not prevent creeping of the rails, nor are short angle bar splices on two ties very effective. But with an angle bar 46-inches long, slotted and spiked and resting on three ties, you have a power greater than the other two methods combined, and this will prevent the joint fastening from moving, while the rails may expand or contract in the splices on account of the oblong bolt holes in the rail ends. Any device which proposes to control the expansion or contraction can only be a subject for ridicule.

WHEN LAID IN A SAG.

17. When a foreman lays a piece of track in a sag which he soon expects to raise up to a level surface, he can raise the track if the sag is not too deep without cutting the rails, by leaving the joints open as much as possible when laying the rails by keeping the bolts in the splices not too tight. Otherwise he will have to cut some of the lengths of the track, because the track in a sag is longer than when brought up to the level surface.

CHANGE OF LINE.

18. In cases where a general change of line is made by moving a curve track inward several feet the foreman should have his men dig out all the material which is used for filling between the ties for the full distance covered by the new change in track line, so that the ties will not crowd against each other or injure the surface by raising up on top of the ballast. Before commencing to line the track, take out and set aside one rail length of the track in the middle of the curve. Then loosen up the track with a jack or lever bars and blocks. Start lining gangs at one or both ends of the curve and work toward the middle, moving the track toward the new line 12 to 20 inches, or as far as it can be pulled

conveniently with one lining, without kinking the rails or splices. Continue thus until the opening in the middle of the curve is reached. Then go back and commence again as near the end of the curve as may be necessary, and work toward the middle as before. Repeat this process until the inside rail of the track has been moved beyond the center stakes for the new line, bringing in both ends of the curve alike. Then while part of the men are spacing and squaring the ties, and throwing in surfacing material, etc., go over the ground with a handy gang of 3 or 4 men, and line the track to the center stakes. Do not cut the rails to fill up the opening at the middle of the curve until all the lining of the track is finished. Otherwise the rails may not fit after all the lining is completed. Lining from the ends of the curve toward the middle always forces the track to move forward toward the opening. By moving the track a little past the center stakes with the first lining, and then throwing it outward to its place when finishing the work, prevents buckling or jamming joints together and makes the track less difficult to handle. The latter operation stretches the track, and opens up joints that might otherwise have proved too tight for conveniently maintaining a good line in the future.

When the change of line is so great that the new line is some distance clear of the old track, it is sometimes a better policy to lay a new section of track throughout, than to try to move

the old piece of track to the place with lining bars.

GOOD SIDE TRACKS.

19. It is a bad habit of some track foremen when putting in a side track to allow the work to be done in a careless manner. The track is surfaced poorly or not at all; rail joints are not square, nor are there ties under the joints except when they come there by chance, splices are loose on the joints, with one and two bolts in them; ties are under the track in all shapes, at some places one foot apart at others three or four feet. In fact, every thing seems to be done as slovenly as possible, because it is only a side track. This should not be the case. All work on side tracks should be as good as on the main track, for several reason; first, that train men may be able to do their work without accident to themselves or the company's property; next, that grain men and others may be able to move a car when loading or unloading without having to call on every passing freight train to stop and switch it for them, and lastly, because a good smooth side track will save burning so much coal, since an engine can switch a greater number of cars more easily than on a rough track. The little extra expense of making a good track when laying it is well repaid in the course of time.

TO STOP TRACK FROM CREEPING.

20. The best method to hold iron or steel to keep it from creeping down grades or from running ahead enough to throw track out of line or kink the rails, is to use the slot spikes in the splices. This can be done only where angle bar splices are used on joints. The advantage gained by putting the slot spikes in the splices instead of in the flange of the rail is that although the joint is held firmly in place, the slot spikes do not interfere with the contraction or expansion of the rails, and if the track is spiked and laid in this way and given the proper allowance for expansion, it will never give any trouble.

MAKING CONNECTIONS.

21. At any time when laying rails on main track or side track, never make a connection with a piece of rail shorter than ten feet. When you see that only three or four feet of rail is necessary to connect the two ends of a piece of track, add the three or four feet to the length of the rail adjoining the space, cut two pieces of rail half the length of the total number of feet, and put them into the track to make the connection.

SHORT PIECES OF RAIL.

22. A piece of rail less than ten feet in length is of the most value to a railroad company when returned to the rolling mill. Except in cases where it is absolutely necessary to use short pieces of rail as at the ends of frogs, in the round house tracks, etc., the extra expense necessary to prepare them so that they will be perfectly safe in track, (safety is the main point to be considered), will offset the difference in value between old and new rails of equal lengths. A track foreman can generally avoid making a short connection, especially when laying old rails, by selecting lengths of rail that will leave him 15, 20 or 25 feet of space for connecting, as any of the lengths mentioned can be cut from a good 24, 26 or 30 foot rail that has been battered on one end.

THE STEEL CAR.

23. The men selected to work on the steel car in laying track should be strong, healthy, active men, all of whom speak and understand plain English. Men of different nationalities, no matter how good physically, should not be allowed to work together on a steel car. Where such is the case accidents are of common occurence and the work does not progress as well as

when the kind of men first spoken of are employed to do the work. The foreman on a steel car should be a man of energy and experience, when possible to procure such a one, and he should be equal, if not superior, to his men physically and intellectually.

LINING NEW TRACK.

24. When a new road is first laid the engineers put stakes along where the center of the track should be. These stakes are generally set about 100 feet apart, and a tack is driven in the top of each stake to show the correct center of the track. The man whose business it is to line the rails behind the track layers, always carries with him a small light wooden gauge with the center marked on it. The manner of lining new track is as follows: The track liner places his gauge on top of the rails across the track over one of the center stakes. His men then lift the track to one side until the center mark on the gauge is directly over the tack in the top of the center stake between the rails. This part of the track is then allowed to remain in that position and should not be moved again. After the track liner has put the rails in position at two or three center stakes, he proceeds with his men to put the rails between these in a true line with them, which completes the work. Any carelessness on the part of the track liner in the matter of put-

ting the rails in their proper place at the center stakes, is apt to cause trouble when the track has been surfaced, as it is often difficult for the trackman in charge of a section to get a perfect line on his track at places where the first track liner left swings in it, because numbers of the center stakes are lost or moved out of position, during the work of track laying.

TRACK LINE.

25. After a railroad track has been properly surfaced the rails should be put in a perfectly true line. Few track foremen seem to give this part of the track work the attention that it deserves, and even on first class railroads it is seldom that any thing like perfection in the line of track is attained. Of what avail is all the other work done on a piece of track if it be not in good line and gauge? The surface may be perfectly level and smooth, but cars will ride badly over it at high rates of speed. The wheels following the crooked line and bad gauge, cause the cars to dance from one side to the other almost as badly as if the surface of the track were rough, especially on curves, and a bad line or gauge will soon make a track rough, because the heavy rolling loads cause the wheel flanges to strike the rails with great force, where the line is irregular.

There is no excuse for bad line or gauge on track, especially where it is ballasted or foremen raise

it up to surface it. All that is required is a little skill, a good, careful eye, and force enough to put the rails in place, all of which ought readily to be found on any section; while as a matter of fact, some of the track that we see, looks as if all three of the requisites mentioned were almost intirely lacking.

A well lined section is the best indication that the foreman in charge of it thoroughly understands his business, because a good line cannot long be maintained without also having a good surface on the track. In order to preserve the line of track as originally located, and to enable the foreman to keep a true line on the rails, I would suggest that permanent stone monuments be set in the ground at convenient distances along the center of the grade of a double track railroad, or on one side of a single track, and that the top of each stone monument be chiseled square or capped with iron or steel so that a gauge may be tried at any time and show the correct distance between the monument and the nearest rail of either of the tracks. These monuments might also be made the standard from which to take levels when surfacing track, or when ballasting track out of a face, by having the grade levels marked and numbered on each monument; any of the figures on one monument designating the same level on all of them.

ONE OR MORE STEEL CARS.

26. When it is not intended to lay more than one mile of track per day, one crew and one steel car is sufficient. When it is necessary to lay from one and a half to three miles of track, two or more steel cars can be used to get material to the front, and a team of horses should be used after the second car is put on, to pull the load out and the empty car back. The regular steel car crew should never be taken from the front when two or three cars are used. They should only be required to bring back the empty car to meet the load, and turn the empty up on its side to let the load pass it. It is poor economy for track layers, when rushing the work, to have the steel car crew come back one half mile or more to load steel.

HOW CONSTRUCTED.

27. The steel car should be light, strong and compact, and made of the best material, so that it can carry a heavy load and at the same time be easily handled by the crew working it. The wheel's tread should be at least eight inches wide, so that the car can pass over loose and uneven gauged track without leaving the rails. A load of rails with the car off the track often causes considerable delay.

TRACK LAYING GAUGE.

28. The gauge used to hold the rails in place ahead of the steel car should be made of one solid piece of iron with a lip in projection to come down on both sides of the ball of each rail of track. This kind of a gauge serves the double purpose of gauging the track, and of holding the loose rails in place until the car has passed over them.

CATTLE GUARDS.

29. For a good, safe cattle guard, the writer believes that an iron or steel surface cattle guard, which can be put in without excavating under the track to a greater depth than the bottom of the ties,and which will at the same time prevent cattle or other animals from coming upon or crossing it is just what the railroads need at the present time, and that if the proper kind is offered railroad companies would purchase them and put them in, to replace the old stone or timber structures which are commonly used. My chief objections to the common timber cattle guards are that those which are constructed by excavating a hole in the ground and spiking the rails along the top of a single stringer over this hole makes a trap for cattle to fall into, and that if a car wheel or truck is derailed before reaching one of

them there is liable to be a very disastrous wreck.

Cattle guards constructed on the same principle with track or bridge ties along their tops only lessens the danger to some extent, because the ties, if not very close together are liable to break under the wheels, and if cattle attempt to cross such a cattle guard, which is often the case, they sometimes fall through, and in this position they are liable to wreck a train, and cannot extricate themselves without assistance.

I also think that an iron surface cattle guard can be put in and maintained at a less cost to the railroad companies than one made of timber and constructed in the usual way, and its use must result in economy, in keeping a good, smooth track at points where the pit guard would be heaved up by frost in the winter and require the service of section men to shim and repair it very frequently.

LIST OF TRACK TOOLS.

30. List of track tools for a section of 5 miles, foremen and crew of 5 men, as recommended at the Denver Convention of American Roadmasters, Sept. 1889, by the committee on Track Tools:

2 Adzes.	1 Hatchet.
1 Axe.	2 Lanterns, white.
1 Hand Axe.	2 Lanterns, red.
1 Box, tool.	1 Lantern Globe, white.
1 Buchet, water.	1 Level, track.
3 Brooms.	1 Level, boards.
2 Bars, claw.	2 Levels, blocks.

5 Bars, lining.
1 Bar, raising.
6 Bars, tamping.
12 Chisels.
1 Car, hand.
1 Car, push.
3 Cans, oil.
1 Can, water.
2 Chairs.
2 Dippers.
1 Drill, ratchet.
6 Drills.
2 Flags, red.
2 Guages, track.
1 Grind Stone.
3 Grub hoes & Mattock.
6 Handles, pick.
1 Handle, axe.
2 Handles, adze.
6 Handles, hammer.
4 Hammers, spike.
1 Hammer, Sledge.
1 Hammer, napping.
6 Picks, clay.
6 Picks, tamping.
1 Punch.
2 Pad Locks.
2 Rail tongs.
6 Scythes.
6 Scythe Snaths.
6 Scythe Stones.
6 Shovels.
4 Shovels, scoops.
1 Saw, hand.
1 Saw, cross-cut.
1 Rail Saw for every 50 mls.
1 Jim Crow for every 50 mls.
12 Torpedoes.
1 Track Jack.
1 Tape line.
1 Track Lever.
2 Wheel Barrows.
4 Wrenches, track.
1 Wrench, Monkey.
1 Water Keg.

LOCATING WAGON CROSSINGS.

31. In states where the law is such that the public has a right to use the section lines as public highways, is is a good policy for those in charge of building new railroads to have all the necessary grading done at such points as there is a probability of locating grade crossings in the near future. The work can be done with less expense when the road bed is in course of construction than at any other time.

WHERE TO SPIKE THE PLANK.

32. When locating public or private plank

crossings on their sections, foremen should, whenever it is possible, spike down the plank at the center of a rail, because if the crossing is spiked down where a rail joint comes in the track, when the joint gets low it cannot be raised up to surface without removing the plank to do it, and for this reason is often neglected.

A COMMON PLANK WAGON CROSSING.

33. Seven three inch by ten inch plank will do for a common wagon crossing. One plank is to be used on each side of the track outside and spiked close up to the rails. Five plank are to be used in the center of the track, leaving a space for the wheel flanges next to the rails on the inside. About five inches of the ends of the crossing planks should be dressed off with the adze, leaving a slanting surface, which will enable any objects which strike the end of the plank to pass over them without tearing the plank out of place.

A STANDARD HIGHWAY CROSSING.

34. A standard highway crossing on the C. M. & St. P. R'y., is made by using one plank along the outside of the track rail and only one plank along the inside, and at each end between the inside planks is spiked a short piece of plank forming a kind of box which is then filled with

earth, broken stone or ciders. This kind of crossing where it can be used saves considerable lumber and is both durable and economical. The C. R. I, & P. R. R., and some other roads use a track rail in some of their crossings, instead of the inside plank. This rail is laid on its side with its head against the web of the track rail, thus forming a channel for the wheel flanges to run in. It is bolted to the track rail near each end and its ends are then turned in towards the center of the track and all the space between both sides is then filled up level with broken stone or other material. This style of grade crossing has some advantage in being so easily kept in repair and not requiring the services of track men to clean the ice and snow from the flange way in the winter season. But the item of first cost is considerably more than other crossings on account of the large amount of metal in the rail.

The writer believes that it would pay to have a rail specially manufactured of a much lighter and slightly different pattern which would accomplish the same results in every way as well as a track rail and thus remove the chief objection to this style of grade crossing which I think could be made the best and most economical of any of these here mentioned.

SPIKING AND GAUGING.

1. Track should always be kept full spiked and in perfect gauge. In order to keep it in perfect gauge, a gauge of the standard width should be used, and when track is spiked to gauge, the gauge should be square across the track, about six or eight inches ahead of the tie spiked, and remain between the rails until the tie is spiked. The outside spike should not be allowed to draw the rail too tight on the gauge or to be driven loosely, either of which will affect the width of the track after the gauge is lifted. When gauge is tight, start inside spike first, when loose, the outside spike first. Bad gauging detracts from the looks of an otherwise good track, makes track easier to knock out of line and down below surface, and is also dangerous and the direct cause of numerous wrecks. To be driven properly a spike should rest upon its point almost perpendicularly, when receiving the first stroke, which if delivered right, will leave the spike perfectly straight up and down. The spiker should then try to deliver each stroke in such a manner as not to draw the spike in any direction until about the last stroke, which should draw the head of the spike toward the rail and down to the flange, both at the same time. Care

should be taken never to strike the last blow on a spike too hard, as this either cracks the head or breaks it off, rendering the spike in either case useless.

PULLING SPIKES.

2. To draw a spike in frosty weather, or to draw a spike out of an oak tie at any time of year, tap the spike down on the head with a spike maul once or twice, before attempting to pull it out of the tie with the claw bar. In most cases there will then be no difficulty in pulling the spike without breaking it. Tapping the spike down with the maul loosens its hold on the wood of the tie and makes it easier to remove. If an opposite course is pursued and track men try to pull spikes without doing as above directed, a great number of the spikes will break off under the head.

WHERE TO DRIVE SPIKES.

3. The spikes should be driven about two and one-half inches from the edge of a track tie. The spikes take a better hold in the wood of a tie, and support the tie under the rail better when driven thus. An oak tie will split open on the ends in frosty weather if the spikes are driven in the center of the tie. The tie, so split, will rot much quicker, and will have to be removed from the track sooner than the tie which remains

whole. Another reason why the track spikes should be driven in the sides of the ties is because the wood in the center of most ties is softer and may be decayed, while as a rule, the sides of the ties are sound timber.

GAUGING TRACK IN WINTER.

4. Section foremen should make an effort to gauge all of the track in their charge once a year if possible. Early in the winter, and before general track work begins in the spring, are the best times to gauge track, because at such times, on northern railroads, there is generally less of other work to be done than during the balance of the year. A section well gauged once can easily be kept in that condition ever after.

5. Before commencing to gauge track out of a face, the foreman should get all the necessary tools in good condition, have ready two good spike mauls, two claw bars for pulling spikes, a good sharp adze for dressing a surface for the rail on the ties, two standard gauges, one for gauging the track and one for testing the gauge of track before pulling the spikes; also a good supply of track spikes and wooden plugs to put in the old spike holes.

If there are any very bad places on the section, begin gauging these first, but if the average is the same throughout, it is best to work from one or both ends continuously, marking every

evening where you leave off work for the day.

When you arrive on the ground to commence work, take out all short kinks on the line side and spike the rails to the line, and have your men knock down all loose spikes on that side of the track before bringing the opposite side to gauge.

The foreman should take one gauge and test all the track ahead of the men gauging, and mark all ties where spikes have to be pulled. Keep only enough spikes pulled on the gauge side of the track to make it handy to adjust the rail to place ahead of the gauge, and have the track always ready to close up for trains to pass.

Have one of the men move the rails to place ahead of the gauge with a lining bar, and do not try to draw the rail with the spike more than a quarter of an inch.

Do not spoil or waste any of the old spikes that are fit to be used a second time, and if the old spikes are oily or greasy throw a little dirt or sand on the head of the spike when you tack it in the tie. This will prevent the spike maul from slipping off the spike when driving it. Measure the gauge and be sure it is of the correct length, four feet eight and one-half inches, and if it is an iron gauge and the end lugs touch the joint fastenings, grind or file them off, tapering so that nothing but the rail will touch the gauge when placed across the track. The exact amount of labor expended at gauging track should be charged daily on the work journal, and

the foremen's time should be included in the cost when making estimates of the cost per mile of section.

If the gauge of track on a section is not very bad, a foreman and two laborers will gauge an average of one sixth of a mile per day. Gauging and spike-lining a section of track well during the winter, besides improving the track at that time, will enable the foreman to put a first-class line on the whole section during the following summer, and will materially lighten his other work.

LOOSE SPIKES.

6. A section foreman should be particular to keep all loose spikes on his section driven down in the ties, and tight against the rails. The majority of the foremen are not so careful in this respect as they should be. Loose spikes in soft ties, where track is not level, leave the rail at that place liable to be turned over and cause a wreck. You cannot keep track in good line with loose spikes, and green men, tamping loose ties when surfacing, lose considerable time holding up the ties. These often spring up the center of the rail, spoiling the surface and making it necessary to go over the work a second time.

RE-SPIKING TIES.

7. Whenever it is necessary to pull the spikes out of ties in the track, changing rails or at other repair work, and you find that the old spike holes in the ties will do for spiking the second time without changing the gauge of the track, do not use a fresh place in the ties to drive the spikes, but plug the old hole with a chip and drive the spikes as they were before pulling. Ties soon rot and break off under the rail where spikes have been driven in different places in the same tie, while the balance of the tie may be good, sound wood.

TO KEEP TIES SQUARE ACROSS THE TRACK.

8. All ties should be spiked in a position square across the track, especially when laying new track, which is to remain some time without being surfaced up or ballasted. The spikes should be driven in the ties in such a manner that they will hold the ties in place, otherwise the ties will be twisted out of their proper position and affect the gauge of the track. Spikes should be driven with both inside spikes, or the two outside spikes, on the same edge of the tie, whether ahead or behind. This prevents the ties from twisting out of square.

TRACK NOT FULL SPIKED.

9. When any side track or main track is not full spiked on the inside of the rails, the foreman in charge of it should examine closely all places where the ties have commenced to decay, and when he finds a double or full spiked tie rotted, should remove the inside spike in the rotten tie, and drive it inside the rail in the next single spiked tie. This is very important in the winter, or when the rotten ties cannot all be taken out of the track, because, where two full spiked ties are rotted close together, and the track is only half spiked inside the rails, the distance along the rails to where spikes are effective is from eight to twelve feet.

This is one of the best arguments in favor of full spiking all track, but as a matter of economy side tracks might be excepted, beyond the switch leads.

SPIKING BRIDGE TIES.

10. Holes should be bored in bridge ties, along side where the flanges of the rails would come, for the track spikes to be driven into. The holes should be one-sixteenth of an inch smaller in diameter than the spikes used. Making the holes in the ties a little smaller than the spikes, allows the wood to close up the hole

around the spike when driven, and gives the spike a more secure hold upon the tie than if the hole was bored the full diameter of the spike. There is always danger of splitting bridge ties when the track spikes are driven into them without first boring the holes, because the grain of the wood seldom runs lengthways of the ties, and the work of repairing can always be done easier where the holes have been bored for the track spike, especially in oak ties.

I favor the general use on railroads of a track and guard rail gauge combined, made by putting a lug or projection on one end of the gauge inside the track rail. This lug should be the proper width to fit between the track rail, and guard rail opposite the point of the frog, in order to gauge the wheel channel to a uniform standard on all switches.

SPRING TRACK WORK.

CHAPTER II.

1. When the frost is leaving the ground in the spring time, track foremen should remember to do all the little odd jobs which have been left over or neglected during the winter, on account of frost and snow. Following are some of the most important rules:

Clean up the station grounds and tracks, and pile up neatly all track material or other material which may be scattered about the premises.

Gather up all trash, cinders, old straw and manure from company stock yards, and haul it out to fill up low places or holes on the right of way, or burn it, if necessary.

All switches and leads should be spiked into proper gauge and line, and battered rails replaced by good ones.

Guard rails and frogs should all be examined, and any defects in them noticed and remedied, or new ones ordered to replace them.

All track ties on hand should be loaded on cars, and distributed along the section, where they would be most needed in the track, to have them ready when the time comes for putting them in.

All loose boards on snow fences should be nailed up, and right of way fences should be examined and repaired, especially in low places or where they cross water courses.

Loose plank in wagon crossings should be taken up and cleaned underneath, and ragged or split ends should be dressed with the adze, and then re-spiked to place.

The approaches to all highway crossings should be filled up and fixed, so that teams would have no trouble in crossing the track.

All fence posts, crossing signs, whistling posts and telegraph poles, should be put in correct position and tamped solid.

Shimmed track should be watched, and very thick shims should be replaced by thinner ones as fast as the heaving goes down, and all shims should be removed from track as soon as it is possible to spike the rails to the proper surface.

Go over the section and tighten up all loose bolts, putting on them nut locks or washers

where necessary, and put in good bolts in place of broked ones.

Look out for soft places in your track, and repair to the best of your ability, notifying train dispatcher and roadmaster when any such places become dangerous, and make ditches in wet cuts to carry off the water, widening them or increasing their depth as the frost goes out.

The different kinds of works mentioned above, if looked after now, will enable the track foreman to make much better headway when the rush of summer work begins.

WASH-OUTS.

2. The time of year is now at hand when sunshine, snow and rain, all combine to increase the quantity of water above the surface of the ground, and as the frost goes out of the ground but slowly, at best, there is always danger to a railroad from the accumulation of too much water at one place. This may damage the track by undermining or washing away its supports, or by loosening the earth on hillsides along the track, it may cause quantities of earth, stones, or trees to fall or slide upon the track.

Section foremen should keep a sharp lookout for washouts at all points on their sections.

Ditches should be opened up, and water-ways cleared of all obstructions, and all track, trestles, bridges and culverts should be examined every

day without fail. Where there is liable to be any trouble, the section foreman should remain out with his men day or night, and do all in his power to keep the track safe, always remembering that upon the vigilance of himself and men, may depend the lives of trainmen and passengers.

In case of a dangerous storm the foreman, if his section extends both ways from his headquarters, should send a man over the short end of it, with instructions to reach the section limit as soon as possible, and to remain there and use the necessary signals to flag trains should he find anything dangerous on the way out. The foreman should go as rapidly as possible in the opposite direction towards the other end of his section, leaving a man a sufficient distance ahead of the first break or washout to flag trains following, in case they are able to get over the other end of the section safely. The foremen should note the location and dimensions of all places needing repair; but he should not stop to do any work until the end of the section is reached, and the men have each been posted to remain and flag trains for all the dangerous places found.

The foreman should then go to the nearest telegraph office and report jointly to the roadmaster and train dispatcher, stating fully the condition of the track on his section, giving location and dimensions of all breaks in roadbed or track, bridge and culvert numbers, number of

bents destroyed in bridges, and any other information which would be valuable as a basis from which to calculate the amount of material or force necessary to put the track into good condition.

This will insure the safety of trains, and enable the train dispatcher to hold them at convenient points until the track is passable, and the roadmaster and bridge men will be prepared to get the work done without delay.

After reporting the condition of your section you can go to work repairing small breaks at points where a large gang of men could not work to advantage, but do not call away your men who are flagging at dangerous places, until you are positive that there is no possibility of trains passing there, or the roadmaster has arrived with extra force to protect and repair such places.

Instances have occurred where foremen have stopped to repair the first bad spot found, and allowed trains to run into other bad places on their section. It is always the foreman's duty first to protect those dependent on him for safety, and then to notify superior officers of the condition of their sections. If the whole of the track on your section is safe, send report to that effect so that trains will not be delayed by slowly feeling their way over it.

REPAIRING TRACK.

3. When track is being repaired which has become rough or uneven, all low places should be brought up to surface and both rails on straight track should be level, and on curves the elevation should be uniform to suit the degree of the curve. How to find this degree, instructions are given on another page.

ON LONG SECTIONS BALLASTED WITH EARTH.

4. When a section is long and a foreman is allowed only a small force of men to keep it in repair, it is not a good policy to surface a track out of a face (as should be done when putting in gravel.) A section foreman, if forced through necessity to get up to surface a rough piece of track with a small force, can do so in a short time by adhering closely to the following instructions, which are only intended for section foremen with long sections, a track laid on clay, and a very limited number of men for help. For example, we will say a section foremen is allowed only four men on a ten mile section. Select the roughest part of your section, give one man a shovel, another the track lever or jack, keep these two men with you; the man with the shovel to dig block hole for lever, and assist in raising the low places wherever it is necessary.

When you find a place that needs raising, stoop down and sight the rail. Take an estimate in your mind of how low the place in the rail is which you have sighted below the proper surface, also count the number of ties running each way from the lowest point. Then tell your two men to raise that part of the rail which is the lowest, and when it is up about four or five inches, or so high that dirt can be easily thrown under, take your own shovel and throw under each tie the exact amount of dirt that you think is necessary to bring it up to the proper surface. To do this work properly, so that it will hold track up for some time, the dirt should be thrown under the ties a little at a time, and as far as it can be put toward the center of the track. Because, if the dirt is thrown only under the ends of the ties, a hole is left under the middle of the tie inside of the rail, which will fill with water when it rains and become worse than before. But if the rules here laid down are followed out properly, a section foreman of ordinary intelligence, after a little practice, may become an expert at this kind of work, and make as good a track as by tamping it in the regular way. A foreman can get over about one quarter of a mile in a day, in good weather. It is best for a man who has never tried this method to practice on very low joints. As to the other two men of the four, they should be left to follow up, dressing the track, filling the block holes, etc. About

two hours before quitting time the foreman should stop raising, take the four men, and line up the piece of track which he has raised, leaving a perfect line on the line side; he should then let two men dress the center of the track, while the other two take a gauge and spike maul, and bring all crooked places in the gauge side to the proper line and gauge. After a section foreman has gone over his whole section in this way, the track will be greatly improved and will look as good as the average dirt surfaced road. Now supposing the foreman has got so far along with his work as to have his section all surfaced up in the aforesaid way, he can go back and pick up small sags wherever he can procure enough dirt to bring them up to surface. These sags should be surfaced out of a face and tamped and allowance made for track settling. When a rail on one side of the track is sighted the section foreman should use the spirit level to bring the opposite rail, which is raised, up to surface.

DRESSING MUD TRACK.

5. When you fill in track with dirt, have your men throw the material in the center of the track. It is much easier to dress it then, than if it is thrown along just inside of the rail in a slovenly manner. Round the dirt off, leaving the center about two and a half inches above the tie. Cover about two feet six inches of the cen-

ter of the ties between the rails, sloping the dirt from the center so that a shovel blade can easily be passed up under the rails between the ties and allow the water to run off. Continue the slope until it runs out at the bottom of the ends of the ties. Outside of the ties the shoulder should slope about one and a half inches to the foot, as far as the edge of the embankment.

LINING OLD TRACK.

6. When a railroad is in operation the track should be kept in perfect line at all times. Nothing contributes more to the smooth riding of a train than a true line of rails. The foreman, when lining track, should line as much as possible with his back to the sun, because in that way he gets the best view of the rails. It is also necessary to look at the track line from the opposite direction, especially when lining across a sag. Very few trackmen can line track perfectly by going over it only once, unless they are experts and have perfect sight. Always stand as far away from the place to be lined as your sight will allow, and train your men to line by the motion of your hands, when first putting the rails in place. By standing too close to the place to be lined, you are liable to throw a swing in the line to one side of the track. This is a fault of many foremen and should be avoided. If you have a section which the previous fore-

man left in bad line, show your ability by remedying its defects in that particular every time you have an opportunity. If a foreman has some track on his section which has settled down and out of line, where the ground is wet or soft, and he has not the force of men necessary to move it, the work of putting it to place can be done with a small gang, by pulling the spikes out of two or three ties in a rail length at a time, and using the lining bars on top of the dead ties under the rails, thereby gaining a solid foundation to rest the bars upon, and much more leverage than could be got with the bars in the ground. After the track has been lined to place, the dead ties can be shifted to their proper position or the rails can be spiked down on them temporarily as they lay. When the track has a tendency to slip back out of line, the dead ties act as a brace to keep it in position. Very heavy track can be lined over to where it is wanted with a force of only two men by using a track lever or long bar on top of a block of wood with a rounding top surface. Place this block underneath the rail on that side of the track towards which it is desired to line it to. By pulling down on the lever a lifting pull is exerted, which draws the track towards that side, and with the assistance of another man on the opposite side of the track pulling in the same direction with a common lining bar, the track can be lined to place. Foremen whose eye-sight is not equal

to the task, can assist themselves when lining long stretches of track by placing clods of dirt or other small objects along on top of rail joints where the track has to be moved. It is much easier to get the small, dark objects into a true line, on account of the contrast between them and the rail, than it is to line perfectly a long stretch of rail, with its brightly polished and unbroken surface. Some of the instruction here given as to track lining may seem unimportant, but a knowledge of how to act in certain cases is often the want of a track man, and to the young man not much experienced or learned in the track service, they will be found a valuable help.

BOLTS THAT ARE TOO TIGHT.

7. Some trackmen think that all bolts should be kept as tight as it is possible to make them. But it is an error that any trackman will fall into, until he is convinced to the contrary. There are several kinds of nut locks for track bolts in use on the railroads throughout the United States, the majority of which are devised for the purpose of locking the nut, and, at the same time, allowing the rails to contract or expand after the bolts are tightened without danger of breaking the bolts. But the section foreman and his men come along, and tighten up all the bolts on the section, even if they can only make a quarter of a turn with the wrench. In fact, many foremen

add pieces to the ends of the track wrenches, so that the men may be able to get more leverage, and as a result of their labor everything on a joint in the shape of a nut, lock, or washer, whether it be iron, or steel, or wood, or rubber, has every particle of spring or elasticity taken out of it, and the bolts all stand ready, the moment a train passes or a change in the temperature comes, to pop off as they break like so many candy sticks and numbers of them can be found along the track. Many of the nut locks which are used as above are no longer of any value except as washers to cover a few threads of the bolt. A joint with either four or six bolts in it, with a spring nut lock on each bolt, should have the nuts tightened just enough to get the full force of the resistance of the material used for a washer between the nut and splice. A comfortable twist of the track wrench with the hand, after the nut is run up to place will be found sufficient force to use when tightening bolts. When bolts are tightened in this way and there are angle bar splices used on the rail joint slot spiked to the ties all danger of the bolts or rails being injured is avoided, and the rails can contract or expand without track creeping. A slot spike through the rail flange in a tie with the bolts in the joint as tight as they can be made will either break the bolt or kink the rail near the spike, or throw the track out of line in hot weather. To prevent track men from breaking bolts when

tightening them, track wrenches should not be made longer than sixteen inches for $\frac{3}{4}$ in. bolts.

REMOVING OLD TRACK BOLTS.

8. When removing old track bolts from a joint splice, foremen should not allow their men to strike the thread end of the bolts with a wrench, a hammer, or any tool that would injure the bolt. Such usage spoils the bolts for further service. Nor should foremen allow their men to break the bolts out of a joint except in a case of emergency, such as to get ready for an expected train, or when a large gang of men, ready for work, might be delayed too long by waiting to remove a few bolts with a wrench. The nut should not be entirely removed from the bolt while in the splice until the bolt is loosened. A light tap on the nut when nearly off will loosen the bolt in the splice without injuring the thread. The threads of the old bolts should be oiled, and then nuts put back on the bolts again, so as to have them ready to use when wanted.

CHANGE OF TEMPERATURE.

9. All sudden changes of temperature affect the bolts in the rail joints on account of the expansion or contraction of the rails. This is most noticeable in the spring and fall of the year.

Foremen should not neglect to tighten up the bolts when they begin to rattle as trains pass over, or at any time when it is necessary. Always remember that loose bolts make low joints, and increase the labor of track repair.

LINE OF BRIDGES.

10. Section foremen should be particular to keep the rails on all bridges in good line, especially when they heave up or out of line in winter; also keep a good line and surface on the approaches of bridges.

REPAIRING BRIDGES.

11. All repair work on bridges should be done by bridge men or those who have charge of such work. Section foremen should not attempt to raise up stringers or caps on bridges, or do any other work on bridges for which they have not the proper tools or the necessary practice to perform. In the absence of bridge carpenters section foremen can shim up the approaches of bridges when out of surface, or put blocking under stringers which have become loose on pile bridges, etc. All shimming should be done on top of ties when practicable.

THE ENDS OF BRIDGES.

12. The ends of all pile or frame bent bridges should be planked and filled in with ballast, and all dump ties should be tamped solid, up to the ends of the bridges. Whenever it is practicable, the end of a bridge and the dump should meet under the center of the track rails laid over them, because when a rail joint comes on the dump close to the end of a bridge, it is always more difficult to keep the track up to a good surface than if the center of a rail were there.

DITCHING.

13. In order to ditch a cut properly, a foreman should take measurements from the rail to the bottom of the face of the cut, at different places along the cut, and ascertain at what average distance from the track it will be best to have the back of the ditch. This is very important, because in the majority of cuts on a railroad the line of face is more or less irregular and not truly parallel to the track, and the best distance from the track for the back of the ditch is

that distance which will give a good ditch without moving too great an amount of material. After a foreman has decided what width the ditch should be, he should line it with the shovel or drive stakes along the back of it, for his men to work by; otherwise they will be apt to make it crooked. Nothing is more unsightly than a crooked ditch, and it will fill up much quicker than a straight one. The ditch should always be a little deeper at the lower end of a cut, and gradually grow shallower as it goes up grade. If you ditch parts of two or three cuts on your section at different times, each of the cuts will have some time to drain off, the material in the ditches will be dryer and in better condition to work in, and men can do more than if they were kept in one very wet cut all the time. Where water leaves a cut through a ditch, the ditch should be well turned off from the track. Always carry the discharge end of a ditch so far away from the track that there will be no danger of water from the ditch washing out the embankment under the track. Foremen should always select for ditching a time of the year when the weather is not fair enough to do other track work. Some foremen use very poor judgment in this matter, sometimes spending two or three weeks in making a ditch during good dry weather, while there is a great amount of bad track on their section which needs to be put in good repair.

WIDTH AND SHAPE OF DITCHES.

14. The width of a cut and the slope of its face on each side of the track must always govern, to a certain extent, how far from the track rails to have the back of a ditch. All railroad cuts should be opened so wide when the track is first laid that there will be room to make all ditches a uniform distance from the rail. A ditch should be deep enough to thoroughly drain the track, and the distance from the rail to the back of the ditch should be in proportion to the depth of the ditch, giving the water an easy fall from the track and free passage through the ditch, so that there will be no danger of its washing the shoulder of the grade, or undermining the track. Deep ditches close to the track, in a cut, soon weaken the foundation, and wash away the ballast outside the ties, especially where the ballast is sand or gravel. The bottom of a ditch should be ten feet from the rails where the grade width will allow it, and should also be two feet below the bottom of the ties.

SLOPE OF DITCHES.

15. When track is ballasted with dirt the slope should commence in the center of the track, two and one half inches above the ties, and run out for a distance of seven feet, falling at the rate of one and one half inches to the foot.

From this point, which is three feet outside the ties, and two inches lower, the incline should be greater, about in the proportion of four inches or more to the horizontal foot. § It is a mistake to run the slope from the bottom of the ends of the ties, directly to the back of the ditch, as some track men do, because when the track is raised up to put ballast under it, the inclination of the foundation beneath it will be too sharp to protect the ballast from wasting or washing away. If a track is ballasted with gravel, the slope towards the back of the ditch should commence about two feet outside the track rails, as shown in Fig. 2, the ballast at this point being nearly level with the base of the rails.

GRADE OF DITCHES.

16. If a cut is level throughout its length, the ditch should be deeper at the ends than at the middle. Where the grade of a cut descends towards the ends from the center, the average depth of the ditch may be the same throughout the cut. Track men should always begin to ditch at the lower end of a wet cut, and finish up as they go. The piece ditched every day will help to drain off the water behind them.

§. Ditches which are made to conform to this shape are easily cleaned out. They are quicker made, and there is much less dirt to be moved than when the ditch is made dish form, because the water is always thrown away from the track.

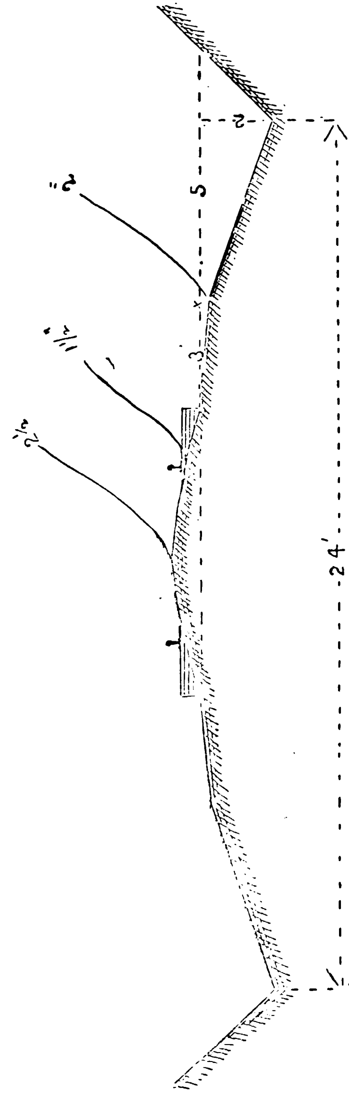

Fig. 1.

Section of Roadbed Ballasted with Earth, Showing a Method of Arranging the Material in Center of Track, Under the Rail, with Incline of Shoulder Outside the Ties; Bottom of Ditch 2 Feet Below Ties.

CLEANING OUT DITCHES.

17. No old ties or other obstructions should ever be allowed to remain in the ditches along the track. All ditches should be cleaned out thoroughly every fall and the last thing before winter sets in, so that during the continuance of the spring rains or while snow is melting, the water can pass off freely without injuring the track A small ditch made with a plow along the top of the side of a deep cut, and near the edge of its face, will carry off the surface water, and protect the side of the cut from washing into the track ditches and filling them up too rapidly.

A DITCHING RULE. [‡]

18. A simple device, like that shown in Fig. 3, is very handy for foremen to use when ditching. It can be made as follows: Use for the long piece a straight edge 1x4 inches, twelve feet

[‡] Many of the deep, narrow, and wet cuts which are common on some railroads, and which it has cost thousands of dollars to maintain in only a passable shape, could as well have been put in a first class condition with only half the expense, if the work had been done before the track was laid. A number of the northwestern roads have adopted the plan of grading down the smaller cuts along their road, with a gradual slope from the bottom of the ends of the ties almost to the right of way limits, in some cases. This nearly does away with shallow cuts. The material is used to strengthen the adjoining fill, and the track at that point is protected from snow drifts in the winter months.

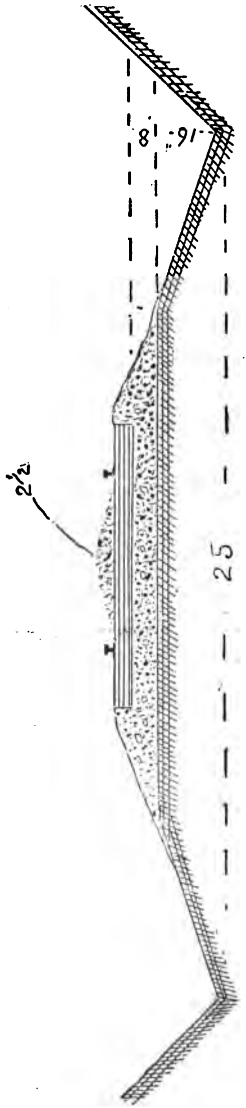

Fig. 2.

Section of Roadbed with 8 Inches of Gravel Beneath the Ties and Filled Level with Top of Ties on the Shoulder of Track; Bottom of Ditch Same Distance Below Ties as in Fig. 1, and 10 Feet from Rails.

long. For the short cross-piece, B, use a piece of board 1x3 inches, four feet long. On one end of the long piece fix a piece of sheet iron, C, twelve or fourteen inches long, double it, and bolt the ends of it through the wood, leaving a space through which the short piece, B, can be passed freely. A hole should be bored through the sheet iron, so that a set crew or a bolt can be used to secure the short piece at any distance from either end of it. The cross piece, B, of the ditching rule should be set so that the back of it will be at the proper angle for the back of the ditch, and upon one side of it should be marked distances by which to regulate the depth of the ditch. When in operation, one end of this ditching rule, D, should rest upon the nearest track rail, and at the other end the material should be removed from the face of the cut, until the cross piece, B, rests in proper position to shape the ditch. Then, by trying the spirit level on top of the longer piece, and adjusting the cross piece to the required depth, the bottom level of the ditch can be carried uniformly throughout the length of the cut, if the track is in true surface, without any change in the rule. Foremen should fit the rule to place at distances of a rail length, or less, and the men will have a guide to work by, and can cut the ditch correctly without any additional labor. A marker can be put on the long piece, which will show where the ditch slope commences outside the ends of the track ties.

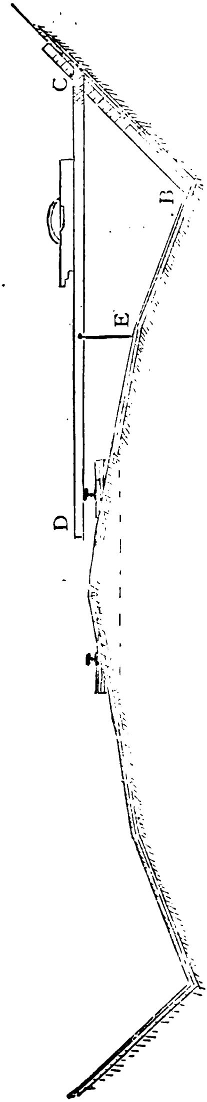

Fig. 3.

Section of Roadbed Showing the Ditching Rule in Position.

If it is desirable to lower the ditch, say twelve inches in as many rail lengths, it is only necessary to let the cross piece, B, down one inch every thirty feet, at the same time keeping the long piece always level on top. In like manner by shortening up the cross piece the ditch bottom can be gradually raised or made more shallow.

TRACK DRAINAGE.

19. A thoroughly good drainage is one of the most essential features of a first class track, to accomplish which, all the water which falls upon the track or adjoining land should be conducted through ditches, culverts, bridges, or other channels to the nearest running stream that will take it away beyond possibility of injuring the track.

These channels for conveying the water away from the track should be sufficiently large to perform the duty required of them *as well during a freshet* as when only an ordinary amount of water passes through them. At all marshy or low places where water remains standing alongside of the track, openings should be made beneath the track to allow the water to pass through, and divide equally on each side of the embankment, and at such places the embankment should be made high enough above the water to insure a solid, dry roadway. The embankment should also be rip-rapped along the sides, if there is any possibility of strong winds

Fig. 4.

Section of Roadbed Ballasted with 8 Inches of Gravel; Arrangement of Ballast Same as in Fig. 2, Except that the Gravel is not Filled Above the Ties Between Rails.

or rapid streams forcing the water against it and washing the material away.

In this connection I wish to say, that where musk rats or minks are plentiful and cause damage to the track by burrowing under it, a good heavy coating of cinders and slag along the sides of the embankment is a most effectual protection against their depredations. Whether the cinders deposit an acid in the water or are too sharp for the animals to burrow through I am unable to state, but I have found cinders a better article for this purpose than gravel or any of the different kinds of earth.

In deep, wet cuts where the material has a tendency to slide, the road bed should be widened out much more than at any other point, and the face of the side of the cut should be made with a very gradual incline from the top of the cut to the track. If it will grow some grass all the better.

The work of widening cuts and road beds can be done cheaper and to better advantage before the track is laid, than afterwards.

The bottoms of ditches which run alongside the track, through a cut, should be carried not less than ten feet from the rails on each side, and they should be as far below the bottom of the track ties as it is possible to have them, and retain a nicely proportioned incline from the ends of the ties to the back of the ditch. Open ditches or tiling which are too close to the track, or not

deep enough below the track ties, are only a make-shift and a hindrance to maintaining a good, dry track. Coarse stone makes a good foundation in a wet cut, if laid beneath the ballast into which the ties are imbedded. (but they can be dispensed with, where the track can be raised *up above the mud without spoiling the surface or grade standard*). In fact, this latter is the most economical method (after a track has been laid) of draining a track and making a good ditch at the same time. Briefly stated, to drain the track in a cut, the same conditions must exist, as nearly as possible, as where the track is laid in ballast on a good, solid fill or embankment, several feet above the surface of the ground the same as where there is no cut.

The incline of the sides of the embankment should be a natural slope, with no abrupt angles. No earth embankment can be prevented from washing without artificial means where the incline is so steep that vegetation will not grow upon it.

Instead of box or open culverts of timber I would recommend that iron tubing or vitrified culvert pipe of a sufficient strength be substituted, this tubing or pipe to be faced with masonry at both the inlet and outlet of the pipes on each side of the embankment; and where the diameter of these pipes is too small to carry off all the water, that there be two or more of them laid across under the track parallel with each other.

I would also recommend that where the conditions are favorable and the cost is not too great, stone arched openings be put under the track, with good, strong, side walls, a paved floor and deflecting wings at both sides of the embankment; these to take the place, as far as possible, of all small wooden bridges.

CULVERTS AND BRIDGES.

20. The policy of most railroads in regard to bridges and water ways, as far as the writer's experience shows, is to contract the limits of bridges and trestles as much as is practicable, because earth is a much cheaper article to support the track where it can be used with safety. This is also the reason why box culverts are substituted for small bridges wherever it can be done, and at many places where it should not be done, as for instance, at points where the opening is not large enough to carry off the amount of water which must pass through under the track. Then the culvert generally washes out, the earth above it is undermined, and the result is a wreck of more or less magnitude, unless the trackmen discover and repair the damage in time.

Even when wooden culverts are covered with earth, parts of the side timbers project on the ends, and there is always more or less rubbish, dead grass or weeds, which accumulates at the mouths of them, making the liability to accident

by fire almost as great as on trestles or bridges.

Where nothing but wood is used in the construction of bridges or culverts, I am decidedly in favor of using small pile bridges instead of box culverts. There is less danger of the bridges washing out, while liability to accident by fire is about the same, and men patrolling the track can see at a glance when an open bridge is safe, while he must often go 20 or 30 feet below the track to examine a culvert.

GRADING CUTS.

21. Wet, soft cuts on railroads are a great annoyance, and very expensive for the companies that are troubled with them. They are the chief cause for increasing the section force and for which ditching gangs and extra quantities of ballast must be furnished.

In the spring and summer the track in wet cuts is rough and sometimes hard to find where there is no ballast under it. Trains must run slow and the wear and tear on rolling stock is greater than at other points on the road. In the winter the track in bad cuts is heaved up, and it requires considerable extra labor and expense to keep it passable, and owing to the frequent spiking and the nature of the material in which they are laid the ties soon rot and have to be renewed. For new railroad construction there is a cheap and effective remedy for the evils above mentioned

which is seldom or never adopted. This consists in widening the road bed in proportion to the height of the cut, or in conformity with the nature of the material through which the cut is made, instead of following out the iron clad rule which makes the width of the road bed the same in all cuts, whether in rock or yellow clay. A practical and experienced man should have full charge of the grading work on a new road, and he should be at liberty to widen the road bed, or ease the side slopes of any cut, in a manner which would protect the track from the effects of heavy rains or a springy bottom.

Surface ditches should be put along the tops of all cuts to run off the water at the ends, and to prevent it coming in on the track over the faces of the cuts.

SUMMER TRACK WORK.

CHAPTER III.

1. The month of May is the season of the year when, on northern railroads, the work of general track repair should be pushed steadily. Track is becoming dry in many places, and heaved track is settling back to its old bed.

Section foremen should select parts of the track at the furthest ends of their sections, and work in the following manner. Tamp up all low places to the proper surface and level; tighten up all bolts; put a good line on the track, and take all kinks out of the gauge side; fill in the center of the track where necessary, and dress it out of a face, cleaning the shoulder of all weeds, and strengthening the embankment at all weak points as you go along. In fact, do everything necessary to make a good safe track. Do not slight anything, and you will have the satisfaction of knowing that so much track as has received your attention is in good shape, when you are called away to do other important work, such as putting in ties, cutting weeds, laying new steel, etc. Add to this good track daily, and save making so many excursions after that particular low joint, bad bridge approach, or battered rail, all of which jobs if looked after separately, consume lots of valuable time.

When the time comes for putting in new ties, those broken under the track rails, or where there are several rotten ties together should be removed first. The work of changing ties should be well done. Ties should be properly spaced, laid square across the track, and tamped solid up under the rail. The number should be increased wherever there was wide space between the old ties, or in order to get a good hewed tie under the center of every rail joint.

Track should not be ballasted or surfaced out of a face in the northwest earlier than the 15th of May, nor should new steel be laid until the track is in a good condition to receive it, except when a gang of men is furnished to go along and fix the track as fast as it is laid. But such work is better if delayed until the weather is warm and the ground thoroughly dry.

By the first day of June, section foremen should have their track in as good a condition as possible, so as to give most of their time to cutting weeds and surfacing track, without having to do so much general repair work.

TRACK TIES.

2. Having had considerable experience for a number of years in making and laying track ties, and removing old ones from track, and noticing that the subject has received some attention by other writers, I should like to add a little to the information already advanced.

Taking a practical view of the question, I am compelled to differ from those who advocate keeping the heart side of a tie above the ground, and should prefer laying all ties in the track with the sap side up, especially ties made by splitting a log of timber in two parts. Such ties will lie better, shed water better, and last longer, than if turned the opposite way.

The shape of a tie, itself, will generally de-

cide what way it should be laid in track, notwithstanding any theory to the contrary. Preference is always given to the wider side of a tie for the base, and this will bring the heart side down in either a quarter or half log tie. In the pole ties there is no preference worth considering, except as to width of face as above referred to. The kind and quality of timber from which track ties are made, is a question of much more importance to a railroad company, as the difference in the length of life and service of ties made from various kinds of timber is so great that a saving of more than half the cost may be effected, in some instances, by selecting the most lasting timber.

It is not always possible to procure the best ties, *but an effort should be made to have them above the average, even at an increased price.* Other things being equal, a railroad which is not compelled to renew its track ties for nine or ten years after they are laid in the ground has an immense advantage over a road that must renew its ties once in five years. The latter road must figure into its expense account *almost double* the *cost for material, besides the additional track labor necessary to do the work*, and during the interval it cannot have as good a track as the former. Ties sawed square will rot quicker and break easier than hewed ties, and are generally too small to give a good bearing surface. But pole ties, with a face on two sides, made by saw-

ing slabs from them, are generally good and preferable to quarter ties or ties split out of very large logs, because the wood of a big tree is more brittle than that of a younger growth. A well hewed pole tie, with a face on two sides, eight to ten inches wide, is preferable to all others for track purposes. No tie should exceed seven inches in thickness, and all ties should be cut a *uniform length* for main track, except in bridges and switches.* The life of a track tie is not altogether dependent upon the kind or quality of timber used.

The same kind of a tie will last longer at the North where the ground is frozen all winter, than in the South, where the process of decay goes on uninterruptedly. There is also a marked difference in the effect on ties of an extremely wet or dry climate.

* It seems to be a very difficult matter, when constructing a new railroad, or when procuring new ties for renewals, to secure ties of a size that will be uniform in width of face and thickness. In regard to the length of ties, I believe the ugly and irregular line of ties on the gauge side of track, caused by the difference in the length of ties, is the result of gross carelessness in the officer or company that accepts them from the tie maker. If ties were all of a uniform length, besides improving the track, it would prevent uneven settling of track; and by lining evenly on both sides, they aid the track foreman in arranging the ballast a uniform width on each side of track, and prevent the useless work spent in tamping the long ends and digging out for them, and on mud track it would lessen the labor of weed cutting.

PUTTING NEW TIES UNDER THE TRACK.

3. When putting ties under the track the foreman should never allow the men to dig out any more than is necessary to allow the tie to go under easily. The old bed should not be disturbed if the new tie will fit. A very good method for putting ties in a mud track, where there are a good many ties to be changed, is to dig out between every two rotten ties, and on each side of the track, a little deeper than the bed of the ties, pull the spikes from the old ties, spring the rail on a tie either side of the hole which has been dug, and slip a spike under the rail. Use nothing thicker than a spike. Then knock the old ties into the hole, and pull out. Pull the new tie into the same hole from the opposite side of the track, if it is of about the right size; let a man on each side of the track slide the tie into its bed, keeping it close up to the rail until in its place. If the place to receive the tie is a little too deep, scatter a shovel or two of fine dirt evenly over the bed, then slide the tie under the rail as before. When both new ties are in, take the spike from under the rail, and you will find both ties in better shape than if tamped under for several minutes. The ties will hug the rail and very seldom be over an eighth of an inch too high, an error which cannot be seen after the first train passes over.

The writer has tried all methods, but finds the

above the best, safest, and quickest. When ties are put in this way there is no tamping to be done, and they can be spiked without the necessity of having a man to hold up the ends of the ties for the spiker. This method can only be used when putting ties in a mud track. In gravel or stone, the ties must be tamped, and should be held up to the rail when spiking them.

When men have had some practice at putting in ties in this way, they can put in one-third more in a day, per man, than by tamping; and in much better shape. But it is not advisable to raise the track up to put in ties in gravel, because the gravel will run under the ties and spoil the surface of the track.

New ties should always be spaced evenly; they should be square across the track, and laid so that the same length of tie will project outside of each rail, as very short or long ties, if put to line on the line side, would give an uneven bearing surface for the rails, thereby making track difficult to keep level. The only necessity for a line side on such ties is when laying new track.

SELECT YOUR JOINT TIES.

4. When selecting ties to put under joints, where common splices are used, always choose the best hewed and widest tie you can find, but never bring the shoulder ties close to the joint at the expense of the quarters. Under joints where

angle bar splices are used, put in two well hewn ties of about equal size, and have each tie come well under the angle bar splices not over 6 in. apart. When putting in ties a foreman should divide his gang in such a way that all can be working at once, having each man do the work he is best suited to perform, and when working a large gang of men he ought to have tools enough to work them in separate gangs, because in this way a great deal more work can be done in proportion to the number of men. Ties sawed square should never be put under a rail joint.

FINISH AS YOU GO.

5. When a section foreman is putting in ties out of a face, leaving the track well tied behind him, he should take time each day to level up all low places in the piece of track tied, dressing it up, not only in spots where the ties have been put under, but continuously. He should, if necessary, cut the weeds at the same time, and do any other work that is needed. By doing the work this way, he leaves behind him, every day, a good piece of track, which grows longer as he advances, and shows up to his own advantage, and his superior's satisfaction.

DISTRIBUTING NEW TIES.

6. When new ties are being distributed on his

section, a foreman should be particular to so distribute them that it will not afterwards be necessary to haul them any great distance to where they are wanted. Hauling ties half a mile or more with a push car to where you want them, when they could as well have been put there with the train, *is only a waste of time and labor.*

MAKE THE WORST PLACES SAFE FIRST.

7. When the number of rotten ties on a section is very great, or when the bad ties are in bunches, from three to ten together in a rail length, making the track unsafe, always look to such places first, and get in enough new ties in these places to make them safe, and keep track in good gauge. After you have done this, then will be time enough to commence putting in the new ties out of a face.

When putting in new ties out of a face, if the old ties left in the track are not to gauge, bring to the proper gauge with new ones, don't leave them an irregular gauge.

TIES UNDER JOINTS.

8. When two rail joints on opposite sides of the track are not squarely opposite each other, never try to twist one tie around so as to make

each end of it come under the center of a joint. This makes the joint weaker than any other part of the rail in proportion to the difference between the square of the joints. When rail joints pass each other so much that the center of each joint will not rest on opposite edges of a good tie, put into track another tie, so that the center of each joint will rest on the center of one end of either of the ties. Track is much better and easier to keep up to surface where there are plenty of ties under it. A good method for spacing ties is to have the space between all ties just wide enough to pass a track shovel up between them. Where white cedar ties are used there should be not less than seventeen to a thirty foot rail length.

ESTIMATING NEW TIES FOR REPAIRS.

9. In the fall of the year, or at any other time that section foremen are requested to send their roadmasters an estimate of the number of new ties wanted for repair of track on their sections, the foreman should make a personal examination of every tie in the track in his charge, counting every rotten or broken tie which must be removed from the track before the end of another year. In the statement should also be included the number of ties wanted to repair his side tracks, and any extra ties wanted to fill

wide spaces, which may have been omitted when the track was first laid.

COUNTING THE BAD TIES.

10. When the bad ties are counted, each one should be examined, and tried with a pick, if necessary. Do not run over the track on a hand car, carelessly counting the ties as you go, nor make an estimate of the number of ties wanted, by guess. The number of ties wanted each year for repairs is an important item of expense to a railroad company, and all estimates for new ties should be made as accurate as possible.

WIDE SPACES.

11. When putting in new ties, track foremen should see that all wide spaces are filled between the old ties which were too far apart when the track was laid, or where other foremen neglected to space them properly, putting in two for one, or three for two wherever necessary.

REMOVE BAD TIES WHEN BALLASTING.

12. When a track is being ballasted with gravel, stone or other material, all the bad ties should be replaced by new ones as fast as the

track is ballasted. The work of changing ties is more easily done when ballasting, and costs less; and the track does not have to be disturbed again for a much longer period.

TWISTED TIES.

13. Foremen putting new ties into the track should adze off the edge at the ends of all twisted ties, sufficiently to give the base of the track rails a level surface to rest on for the full width of the tie, at each end of it.

TIES AT HIGHWAY CROSSINGS.

14. When new ties have been distributed along the track; the section foremen should go over his section immediately after the distributing train, and remove to a safe distance all ties which are close to the track rails, or in a dangerous position. All ties on the ground close to highway or farm crossings should either be put into the track at once, or removed to some place where there would be less danger of their being stolen, or obstructing the highway. Section foremen should not overlook any crossings when putting in ties; the plank should be taken up, the track examined, and all the new ties needed put in there.

REMOVE THE BARK.

15. The bark should be removed from all hewed or round timber used in railrord construction, before it is put into service in the ground, or above the ground.

Bridge piles will remain sound much longer if the bark is removed, and they are allowed to season, before they are put in the ground, because the water which falls on the wood above the surface of the ground, soon evaporates, and leaves the timber in a good, dry condition. If the bark is allowed to remain, it prevents evaporation of the sap, or other moisture, for a much longer time, and therefore induces decay. The same may be said of fence posts, and there is considerable loss occasioned by nails or other fastenings not securing a firm hold on the wood, where they are driven through the bark.

In the case of track ties, (‡) the bark, if not removed, assists materially the process of decay, and it is also a continual source of annoyance to the track men when tamping or repairing the track, and dangerous on account of fire. The best time fo remove the bark from ties is during the winter months, before the ties are distributed along the track.

‡. All track ties last much longer, hold a spike better and give better results generally, if they are thoroughly seasoned before putting them into the track. All timber used in railroad construction should be well seasoned before putting into the ground.

OLD TIES.

16. I believe the best way to dispose of the old ties, which are taken out of the track, is to get rid of them with as little expense and handling as possible. After the section men receive what old ties they require for firewood, the balance should be traded for work, or given away to people living along the road, with the understanding that the old ties be removed at once, after they are taken from the track.

There is a large amount of labor wasted in picking up, hauling, piling up and burning old ties which had better be devoted to improving the track. In most sections of the country where timber is scarce, the farmers living along the track will do plowing or grading, or give labor on the track equivalent to the old ties.

AVERAGE LIFE OF TIES.

17. The average life of ties can only be determined in localities where they are used. Ties made from the same timber will rot quicker in one kind of soil or ballast than they will in another. The climate also effects the life of a tie, as also does the amount of traffic over the road, the width of rail base, etc.

Another point to consider, when calculating the life of a tie, is the condition in which it is al-

lowed to remain in track. Some companies have all the old ties removed from track as soon as they will not hold a spike, while other roads allow old ties to remain in track until they are entirely worthless. The latter roads gain about another year's use of the ties, but it does not pay, except in the case of an occasional tie, broken or rotten in the center, but still giving the rails a good support at the ends. Any tie which has begun to give away under the rail should at once be replaced by a new one. When bad ties are numerous, it is impossible for track men to repair the road without putting under new ties.

18. TIE ACCOUNT FOR A YEAR.

MONTHS.	TIES RECEIVED.		PUT IN TRACK.		ON HAND.	
	HardTies	Soft Ties.	HardTies	Soft Ties.	HardTies	Soft Ties.
January....	1000	500	none	none	1000	500
February ..	none	100	none	none	1000	600
March	300	none	1100	200	200	400
April......	....	....	....	....	....	....
May........	....	....	....	....	....	....
June	....	....	....	....	....	....
July.......	....	....	....	....	....	....
August.....	....	....	....	....	....	....
September.	....	....	....	....	....	....
October ...	....	....	....	....	....	....
November .	....	....	....	....	....	....
December..	....	....	....	....	....	....

Track foremen will find the above form a handy way to keep a correct account of all ties handled on their section. If it is necessary to keep account of more than two kinds of ties, additional columns may be put in under the three heads, "Ties Received," "Put in Track," or "On Hand."

THE CUTTING OF WEEDS.

1. Weeds on track should be cut clean with the shovel between the ties and out to a distance of at least two and ½ feet beyond the ends of the ties, on the shoulders of embankments. In cuts, the weeds growing outside of the track should be cut to the back line of the ditches, unless where grass sod is allowed to grow to protect the shoulder of the track. On embankments, the weeds at a greater distance from the ends of ties than that mentioned above should be kept cut down with a scythe or bush hook, as far out as the right of way limits, if the foreman is allowed men enough to perform this work without neglecting the track or other necessary work. A clean track is not by any means a safe track, and a foreman should not have his men mowing grass and weeds along the right of way, unless the help he is allowed and the condition of his track at the time will admit of it. Before commencing to cut weeds a foreman should grind on the inside of the blade any new shovels he is about to use and bevel them back from the edge about five-sixteenths of an inch. He should also carry a flat file to use when necessary, and never allow his men to hammer shovels on the edge of the blade, as this practice causes pieces to break out of the front of shovels and render them almost useless. A foreman should watch his men

when cutting weeds and see that the weeds are cut under the surface of the ground as those which are only cut off above the ground commence growing immediately after being cut. When weeds are cut in the center of a track or on an embankment the dirt which comes on the shovel together with the weeds should not be thrown down the embankment, but be either turned over or allowed to remain where it was moved from. The practice of shaving off the embankment one or two inches every time weeds are cut is bad, and should not be tolerated, as the loose dirt thrown down the hill soon washes away, and each additional weed cutting of this kind weakens the shoulder, makes the fill narrower and in time allows the ends of ties to project over and track to settle for want of a sufficient foundation.

When cutting weeds, always have your men cut on separate rail lengths, as this relieves the monotony of the work; it also acts as a stimulus, making each one anxious to do his part of the work in time to take his place in turn with the other men.

WEEDS ON HEAVY GRADES.

2. If a section foreman's help is so limited that it is not possible for him to keep all of the track in his charge clear of grass and weeds during the summer months, he should commence

part way up the heaviest grades on his section, and cut the weeds clean out of the track to the top of the grade and down the same distance on the opposite side. This will enable heavy trains to go through without any inconvenience, and the weeds in the sags can be cleaned out afterwards as the foreman has the time to do it.

If the section is all level track you can follow the same plan, cutting the weeds a quarter of a mile or more in one place, occasionally skipping a piece. This will enable an engine to gain speed enough where the track is clear, to haul the train without slipping, over places where the weeds are not cut.

TO LESSEN WEED CUTTING.

3. The labor of weed cutting on a dirt-ballasted track may be lessened a great deal by work done on the section in the spring before the weeds become troublesome, by the following method: At all points where a foreman puts a number of new ties in the track near together, he should stop long enough to surface up the track, line and dress it out of a face, and by this means kill the young weeds or at least retard their growth at that place. After a foreman is well advanced with the work of putting in ties, some of the old ties may be traded to farmers living near the track for plowing a couple of furrows along on each side of the track 10 or 15 feet from the rail,

and in a line parallel with the track, keeping a little outside the bottom of the track embankment. Have this work done where it is high and narrow, especially where the shoulder of the track outside the ties has been weakened by surface washing or from constant weed cutting previous years.

After the plowing has been done the foreman should take his men and level up all low spots in the track and line it up already to fill in and dress. Then put part of the men to work on each side of the track and have them cut the plowed sod into handy lengths and lay them along at the ends of the track ties with the grass side down, and fill the balance of the track in the center and between the ties with material taken from the bottom of the newly plowed furrows and dress and finish the track with it. This work should be continued as long as you can spare the time from other necessary track work and by the time regular weed cutting begins you will have one or two miles of first class mud track with all the old grass or weeds killed. The track will be strengthened and kept in better line, and, there being no weed seed in the material taken from the plow furrows for ballasting, you will be saved the necessity of cutting much weeds on that piece of track all summer, and all your other work will be advanced proportionately.

BALLAST.

1. A better track can be made with gravel and stone combined for ballast, than when either of these materials is used alone. The foundation for the track should be laid with broken stone, and above the stone should be placed a quantity of coarse gravel sufficient to bed the ties, surface the track, and dress it. Where gravel and stone are used together, as above stated, the stone need not be broken as small or uniform in size as where stone is used alone for ballast. Gravel and stone when used for track ballast have, each, advantages peculiar to themselves. Stone makes the most solid foundation, drains the track best, does not freeze in cold weather, does not grow weeds, will not wash, and makes very little dust. On the other hand, gravel is easier to procure along most roads, costs less than stone, is more elastic, not wearing the track ties or iron, or the rolling stock as much as stone, drains the track well, and does not grow many weeds. It also possesses superior advantages in handling, little more than half as much labor being required to surface a given amount of track as when stone ballast is used; and all kinds of track repairs, especially changing ties, can be made much quicker and cheaper in gravel than in stone ballast. Two car loads of

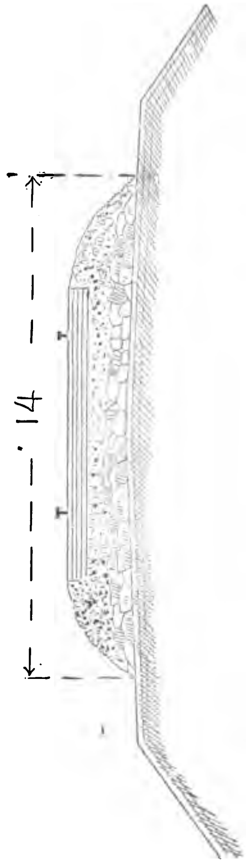

Fig. 5.

Cross Section of Track, Ballasted with Gravel and Coarsely Broken Stone.

gravel to a thirty foot rail length, laid upon a layer of broken stone twelve inches thick, will make a first class road bed, but the proportions of gravel or stone used for ballast should depend on the kind of bottom * over which the track was laid, the cost of materials and the amount which could be furnished.

SURFACE LEVELS.

2. When it is intended to ballast several miles of old railroad, or when ballasting track out of a face behind track layers, levels *should be given by the engineers* just as for bedding ties, with only this difference, that the top of the level stakes should be the surface level of the track rails. These level stakes could be arranged so as to answer for lining track, like center stakes, and in all cases where track is newly ballasted, provision should be made for putting it in perfect line, more especially curve track which should be lined as originally located.

BEFORE BALLASTING TRACK.

3. All track that is about to be ballasted with cinders, gravel, or stone should be cleaned out to a level with the bottom of the ties, and the dirt

* Deep sags should always be raised up the required height before track is ballasted. It is a bad policy and a waste of material to increase the depth of ballast in order to level up a deep sag in the grade.

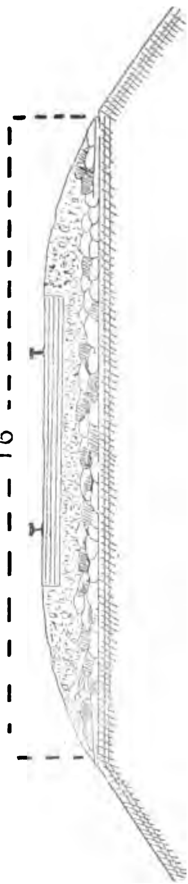

Fig. 6.

Cross Section of Track, Ballasted with Gravel on Broken Stone; Sub-Grade 16 feet wide.

taken out should be put along the shoulder of the grade, to strengthen it and save the ballast from washing away. If the dirt between the ties in a new track is not taken out before putting under ballast of cinders or gravel, it soon mixes with the ballast used, and works gradually to the top in wet or low places, making the labor of repair more difficult, and growing more weeds. Where the ballast is of sufficient thickness, or in taking up sags, the digging out can be omitted. The grade on high embankments before receiving ballast of gravel or cinders, should be made at least fourteen feet wide, and as much wider as is possible without too great an expense.

WHEN TO BALLAST.

4. On northern railroads, track should not be ballasted earlier than May 15th or June 1st. The ground should have time to settle, and the heaving to go down.

BALLASTING.

5. When a foreman is putting ballast under the track he should raise the track out of a face, taking out all light sags where there is enough material to do it.

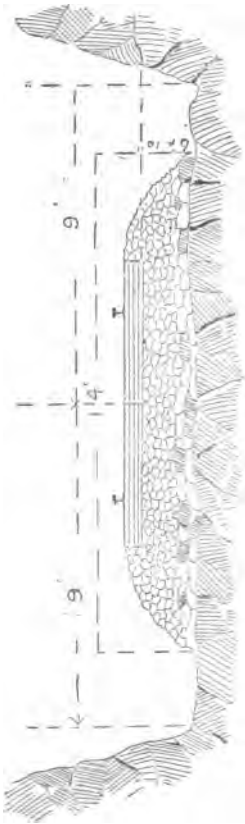

Fig. 7.

Section of Ballasted Track in a Rock Cut.

RAISING TRACK.

6. The following is one of the best methods of raising track to a level surface:

Take a piece of board two inches by four inches and five feet long, place it across the trackway, and cut notches in it three inches deep, near the ends, so that it will fit between the track rails like a gauge. Put this board on a high place in the track about ten or twelve rail-lengths ahead of where you will commence to raise track, shim it up at the end to a perfect level, at whatever height will be the top surface level of the track rails after they are raised at that place; you may then go back and begin surfacing. Raise the first two joints on opposite side of track and tamp them level. Then lay the spirit level aside until you have all the track surfaced up between where you commenced to work and where you placed the sighting board across the track.

When sighting track, have each joint raised and tamped one-fourth of an inch higher than the top of the sighting board, and on reaching the last joint, raise and bring it to a level with the finished track by striking down on the tie once or twice with a sledge, or other heavy tool. The center of the rail should only be raised to a level with the joints.

The man sighting track should sit at least sixty feet back of the joint which is being raised,

and ninety feet back is better, because the long surface of rails raised assists the eye to more accurately sight a true and level line ahead. When track-men sight at the first joint back of the one which is raising, light sags are apt to get into the surface of the track unnoticed, as swings do when men stand too close to a place in track when they are lining.

The above method is simple, less liable to variation, and makes smoother and better track than when the spirit level is used on every rail joint, because the foreman does not have to test every joint with the level and keep the men idle while doing it, nor will he be so apt to pass over a joint which is not up to accurate surface with the others. Use two jacks when surfacing with a large gang of men, a heavy jack for the joints, and a lighter one for lifting the centers of the rails. Do not allow the jack men to lift up rail centers high enough to spring the rails, and always have the jack set in ahead of the joint next to be raised, except when the rail is surface bent in the quarter behind the joint, Tamp up the tie ahead of the joint with the joint-tie when raising track more than two inches. This prevents the joints from hooking over and making it necessary to go back and raise them a second time.

By adjusting a joint some distance ahead to the proper elevation or level and sighting the track into it—a curve track can be surfaced by

the method described for straight track—Always sight curve-track along the inside of the rails. In that way you can see further and better. When making a run off for trains be sure to have it long enough to let them over it easily. Time can be saved by only tamping three ties solid ahead of the last joint raised. The material can be thrown loosely under the balance of the run off and the track let down upon it.

Have your men well organized, each one working in his proper place, and if you employ new men pair them with older hands. If you have a gang of fourteen or sixteen men work them as follows: Put two men tamping out ends of ties on each side of the track, four men tamping the centers of ties inside the rails, and two men with the jack. The balance of the gang may be divided, a part of them filling in the ballast ahead of the men tamping and the others filling in behind the men tamping. If you work your men so that they will be about evenly divided on each side of the track they will be more apt to compete with each other and help forward the work. You can see at a glance whether each one performs his share of the work or not and you will also be prepared to finish up a piece of track quicker, when necessary, than if the men are allowed to straggle along and work where they please.

For inexperienced men it is a good method to sight track over the tops of two small blocks

which are of an equal height with the sighting board or a painted line upon it. The man with the track-jack carries one block, and when the top of this block is placed on a rail-joint and comes up level with the sight-board and the top of the track-sighter's block, the joint is high enough. These blocks are not used when sighting the centre of the track-rail.

RAISE BOTH SIDES.

7. It is best to raise both sides at once when ballasting, as track raised and tamped on one side before it is on the other always has a space not tamped under the rail, on the first side, when the opposite side is brought up to level. The center of ballasted track should never be tamped solid, it will be enough to fill under the centre of the ties without tamping very solid. About eighteen inches inside the rails on each side of track, will be enough of the inside of the ties to tamp solid.

SOLID CENTERS.

8. Where the weight of the engine and the cars bears most on the centre of the ties, great numbers of them break, especially ties sawed square. On Northern roads when the frost is leaving the ground in the spring the ends of ties

thaw out first and where they are very solid in the center they rock under the weight of a train and the track slides out of line.

HIGH PLACES.

9. Short high points in the track to be ballasted should not be raised at all if they are higher than the surfaced track, but should be let down, if this requires less labor than to surface up the track to the high point.

UNIFORM TAMPING.

10. The secret of putting up good smooth track that will remain so a long time, lies in having your men well organized and in getting them to work as nearly alike as possible; uniformity in the work is everything. A first class track can be ballasted without tamping it with either tamping pick, bar or shovel handle, where sand or gravel is used, by having the men put the material to place under all the ties with the shovel blade, tamping only the joint ties, and picking up the low places after the trains have passed over it.

DRESSING BALLASTED TRACK.

11. When the ballast is composed of gravel,

sand, and loam, and only a small quantity is used, the track, when dressed up, should be filled in the center a little heavier than dirt ballasted track and the ballast gradually sloped off on both sides from the center of the track to a point at about half the thickness of the ties at the outer end. If the ballast used is coarse gravel, or cinders, and there is sufficient ballast under the track to drain it well, it is best when dressing the track, to fill up between the outer ends of the ties with ballast, leaving it level with the tops of the ties and then putting a good heavy shoulder of the ballast outside the ends of the ties, dividing the material evenly on each side of the track. The shoulder of track should be of a regular width. Where there is a surplus, put it at weak places.

A DAY'S WORK.

12. Sixty feet, or two rail lengths, of finished track ballasted per man, per day, is generally considered fair work for a surfacing crew. If possible, a foreman should finish up, before leaving for home, all the track raised during the day, as a heavy shower of rain, or a storm of snow or sleet will injure any track which is left open and not filled in the center between the ties.

A little good judgment will enable any foreman to so arrange the work, that, when himself and his men get through work in the evening,

the track where they were working will be in good shape, and safe, if they were not to return again for several days. It is very important that all track should be filled in and dressed up as fast as it is surfaced, in order to preserve a good line on the rails. Track which is not filled between the ties will not stay in line. The heavier a track can be filled without interfering with its drainage, the better it will stay in line, but no material should be piled upon or around the track ties which would in any way stop the free passage of water which falls on the track.

REFUSE BALLAST IN CUTS.

13. Only the cleanest of gravel ballast should be unloaded in cuts to ballast track with. Where it is necessary (in order to get rid of them in the pit) to haul out on the track, together with the gravel, large stones, grass, sods, etc., they should always be dumped on an embankment where they will assist in strengthening the fill. If they are placed in cuts they must be removed after the track is ballasted so that the time spent at this work is wasted. This lost labor amounts to considerable when many miles of ballast is handled. There are very few gravel pits where an occasional train of clean gravel cannot be procured and even where part of the train load is composed of poor material, when unloading it, the worst cars can be cut off and left outside the

end of the cut, and the cleanest gravel unloaded in the cut.

HAVE THE TRACK READY.

14. When ballasting track or raising it to surface, the foreman should so arrange his work that he will have the track ready for trains when due to pass there. He should make a "run-off" at the last rail of track raised. and outer ends of ties should at least be tamped up before a train is allowed to pass over it. The length of the "run-off" should be in proportion to the height the track is raised. Never make a "run-off" too short, it is better to flag a train and hold it until you are ready, than to risk surface, bending the rails, or wrecking the train. Foremen ballasting track should always protect themselves against wild trains by keeping a flag out against them and off the time of regular trains.

HIGH RAISING.

15. When track is raised more than six inches high to put ballast under it out of a face, the foreman employed to do the work should be thoroughly competent and reliable. One foreman should work the larger part of the surfacing gang, and with them lift the track, tamp the ties, and do a part of the filling, leaving the track be-

hind him with a true surface, perfectly level, and in good line. Working some distance behind the first gang another foreman with a smaller crew of men should do the finishing work. He should carry, besides his other tools, a full set of tamping bars and raise up to surface all depressions in the surface of the track made by trains which passed over it after the front gang left it. Every piece of track taken up to surface by the second gang, should be tamped solid to a perfect surface with tamping bars, they should also put a true line on the rails and fill in the balance of the gravel, and dress up the sides and center of the track, moving all surplus ballast with their push car to points along the line where it is needed to make the shoulder of a uniform width.

GRAVEL REQUIRED TO BALLAST A MILE OF TRACK.

16. Allowing an average of thirty-three feet for each car length, including the space between the cars, one hundred-and-sixty-three cars of gravel will reach over one mile of track. If this amount of gravel is unloaded by hand, or plowed off from the cars, which is a better way, and if the trains average about eight yards of gravel to the car, there will be gravel ballast deposited along the track equal to six inches in thickness, twelve feet wide on top, and and twelve feet six inches wide at the bottom for the entire length of one mile of track. De-

duct from the above amount of gravel about one half for filling between the track ties and for dressing the center of the track after it has been surfaced up, and there is still left a balance of about three inches in thickness to be put under the bottom or the track ties.

If two cars of gravel are unloaded at one place, the depth of gravel ballast under the track ties is increased about three fold.

The only loss from the second carload of gravel is about one-twelfth, which goes into the side slope of the shoulder of the fill.

The second car leaves a load of gravel 8½ inches in thickness beneath the track ties. This is a good argument in favor of ballasting with not less than two carloads of gravel in a place. One car load in a place makes a very poor job, especially where it is put under the track without digging out the mud from between the ties.

Where the sub-grade is well drained and solid, a first class track can be made by ballasting with two cars of gravel in a place, and to do the work in this way, estimates may be taken at the rate of three-hundred-and-twenty-five cars of gravel to the mile of track. The embankment should not be less than fourteen feet wide on top, and should be made sixteen feet wide, if possible, before putting on the gravel, to prevent the ballast from washing away.

LEVEL TRACK IN YARDS.

17. The track in all yards should be surfaced level throughout their entire length, and all tracks running parallel with each other should be of the same height when possible to have them so. When tracks have once been put to a uniform level surface, no part of them should be raised again higher than the rest of the yard unless it is intended to raise the level of the whole yard. Many ignorant foremen, in charge of yards, think it is necessary every time they repair track, to surface it a little higher, and a difference of several inches in the heights of the tracks may be seen in some yards. This is a harmful and senseless policy and should not be tolerated.

HOW TO LEVEL YARD TRACKS.

18. A simple method by which to get tracks which run parallel to each other, to the same height, is as follows: First, put up the main track properly, then use a straight edge from the nearest rail of the adjoining track in order to raise it to a level with the main track. You can then move to a point several rails ahead on the main track and repeat the operation. After this you can raise and sight, level the track on the siding between the two points which you have made level with the main track. A foreman can level a

track length way some what in the same way as above described.

RULE—Run the level and a straight edge on the top of two or three stakes running parallel with the track to be leveled, and do the same at a place some distance from that point. Then sight over the tops of the stakes at both points, and have a man drive stakes between the two places where you have leveled, until the stakes which he has driven, are at the same height as those you have leveled with the level and straight edge. The top level of the stakes will be the level of the track rails. In important yards the company's engineers generally give level stakes for all tracks.

GRAVEL PITS.

19. A few words about the gravel pit will not be out of place in this book.

On roads where stone, or other kinds of ballast is scarce, or cannot be procured, a gravel pit along the line is very desirable. There are very few roads that cannot find at least one or two gravel pits along a division.

After the gravel pit has been purchased, and when the work of removing the gravel is about to commence, the foreman in charge of the work should thoroughly examine the lay of the land and find out how his track must be laid in order to get the deepest face of gravel to work on.

Of course, at the same time, the best location for the track must be arranged for the accommodation of trains, and this should be done with a view to future improvements.

The track should always be longer than the face of the gravel in the pit, so that one, ten, or any number of cars could be loaded without danger of spoiling the line of the pit face. This is very important, because where a short track is put in on account of a handy place to put in the switch, or for the reason that there is not much gravel needed at the time, the face of the pit contracts and becomes so short that the loading place is only like a sink hole in the ground, and it soon becomes difficult for an engine to pull out of the pit more than two or three cars at a time, making necessary six or seven switches to do what could be done in one, with a good track. Besides this, there are other reasons why a short track should not be used. The men loading the gravel keep lining the track over as the bank recedes and there is soon a heavy curve in the track which follows around the edge of the excavation, so that it is only a short time until the track has to be torn up and the work all done over again. Now is the time the loss occasioned by gouging a hole in the bank is discovered. If the track is laid along the face of the pit, cars can only be loaded at either end of the pit, and there is loss of time from placing cars, switching etc., and perhaps the two ends of the pit next the track

are not long enough together to allow a full train of gravel to be loaded at once, and there is no help for it except to work at the ends of the pit until the gravel can be reached all along the track.

Another argument in favor of a longer track, is that the face of the gravel can be increased in depth by lowering the track.

Foremen in charge of loading gravel should see that the men load gravel in one place until there is a space on that side of the track at least two or three feet lower than the ties and wide enough to let the track into it. The track should then be lined over and the men could load on each side of the cars. Every foot that the face of gravel can be deepened, makes the cost of loading it less, and reduces the proportion of top soil which mixes with the gravel. Men loading gravel on cars will load more cars, if paid by the car, than in any other way. When the work of loading is not let to the men in the above way, the foreman should divide his gang so many men to each car; this makes them compete with each other.

The steam shovel, with a sufficient number of gravel trains, of flat cars, and one or two plows and wire cables, is the best equipment to use, for economically getting out gravel from the pit, to the place where the track is to be ballasted.

GRAVEL VS. WEEDS.

20. When ballast is scarce or the business of a railroad will not warrant an expenditure equal to ballasting the whole road, it is a wise policy to put gravel ballast on a part of each section, more especially on long sections with only small gangs of men to keep up the track. When possible, the gravel or other ballast should be put on that end of the section which is the farthest from the section foreman's headquarters. Besides the saving effected on a long section, by reducing the cost of cutting the weeds, the ballasted piece of track, being the best part of the road, will save for the company many hundreds of dollars which would otherwise be paid out for pumping a hand car the extra distance to and from work every day. The cost of cutting the weeds on eight miles of a dirt ballasted track for one season, on many railroad divisions, would pay for the loading and hauling of gravel, and putting in first class condition two miles of track or one fourth of the eight mile section. Putting the ballast under the track in small quantities at a time in one place, need not cost the company anything extra, as the section crews can do this as well as cut the weeds, and in most cases the work will be better done than by an extra gang.

It costs less to maintain a gravel track in first class condition, after it has been put up properly,

than any of the other kinds, whether of mud, cinders or stone, and the ratio of cost increases from gravel to stone, as the ballasts are named respectively.

FROGS AND SWITCHES.

CHAPTER IV.

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TURNOUTS.

1. A turnout is a curved track, by which a car may pass from one track to another, and consists of a frog, a rail leading to the frog, a corresponding opposite rail, and a device connecting these rails with the main track, called the "switch." If a switch is made to serve two turnouts, it is called a "three-throw switch," a

"trailing" switch, is one where a train on the main track passes from frog to switch; while a "facing" switch is one that approaches in the opposite direction.

The common or "stub" switch, consists of a pair of connected rails, A C, and B D, Fig. 8, so arranged that while one end is fixed, the other can be moved so as to be a part of either the main track, or turnout. The fixed end is called the "heel," and is the beginning of the turnout curve. The other end is called the "toe," and the distance it moves in passing from main track to the turnout rails, is called the "throw." The toe rests on a large piece of timber, called the "head block," on which are placed the "head chairs," and "switch stand." The rails between the head block and frog, are called "lead rails." The "total lead," includes the switch and lead rails, and should be a simple curve considered as joining the two long ends, one of them, IF, is the turnout line of the frog produced, until it intersects the opposite rail, the other I A, is the opposite rail. As two tangents to a curve from any point are equal, I F, and I A. are equal. The length of lead depends on the gauge and frog number, and is equal to the gauge multiplied by twice the frog number. The switch rails are spiked for a certain part of their length, then when they are thrown, the free end will bend to an arc of a circle, and fit the line of lead. K L, and K' L' are called guard rails,

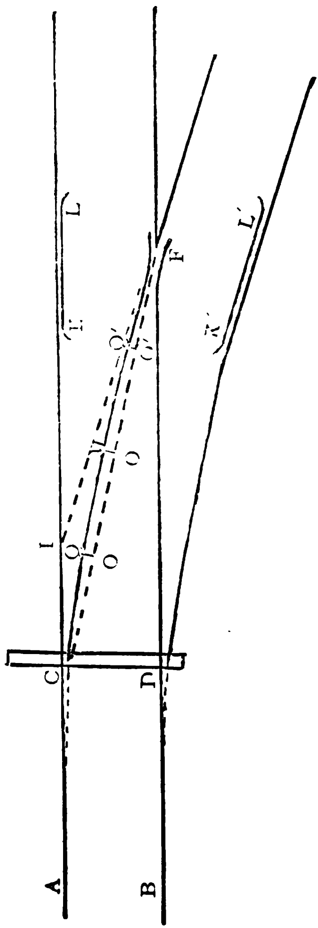


Fig. 8.

M O, is the middle ordinate of the chord C F, and Q O and Q' O' quarter ordinates.

The stub switch has two serious defects, one of which, is want of safety. Statistics show that fifty per. cent. of derailments are caused by defects and misplacements of stub switches. The second objection is the necessary space at the end of the moving rails, which jars the rolling stock, batters the switch rails, and causes some discomfort to passengers.

LAYING SWITCHES.

2. In laying switches, whenever possible locate the frog with a view to prevent cutting rails. After you have determined where the frog point will come, mark the place on the track rail, take from the turnout table the distance from the head block to point of frog corresponding to the number of the frog which is used, add to this the distance from the theoretical to the blunt point of frog, and you have the correct length of lead. The head block can now be located by measuring the total distance obtained ahead of the frog point.

Make marks with chalk along on the flanges of the rail between the head block and frog, so that the switch ties can all be placed the proper distance apart from center to center. After the switch ties have all been cut the proper length, lay them out alongside the track, and see that

each tie is numbered, and in its proper place as it will lay in the track. Then take out the cross ties and pull in each tie in regular order.

When pulling the ends of the ties to line, time can be saved by using a gauge, made by nailing a cleat across a piece of board, allowing eighteen or twenty inches to project beyond the cleat. Have this gauge square at each end, lay it with the cleat against the end of each tie and draw a chalk line across the tie at the end of the board, marking all the ties the same length from the end. This chalk line should be at the outside flange of the rail and have the spikes driven in it on the line side. When the ties are all in place under the track, the ends of all the ties will line uniformly. This is a much better way than measuring the end of each tie with a stick or the mual handle. The switch ties should be put in from either end, just as you have the time to spare between trains. If trains are running close together begin at head block and select the time longest between trains to put in frog and lead. At least two long switch ties should be put in behind the frog to obviate the necessity of adzing and crowding short ties past each other where the two tracks separate.

Before taking up a rail in main track, cut a rail of a length that, with the frog, will replace the rail taken up, and give you the necessary opening at the head chair joint, if a stub switch. Use two full length thirty foot rails for the slid-

ing rails so that enough of the ends can be spiked safely beyond the cross rods. Have the cross rods an equal distance apart, and use five of them instead of four, if you can get them. Then put the head chairs in position under the ends of slide and lead rails. The lead rails should be properly curved or the switch can never be kept in a good line. As soon as the lead rails are connected between frog and head chair, the main track should be spiked full, and put to a perfect level surface and line before the lead is permanently spiked. An experienced track man with good eye-sight, can line the lead curve, but it is better to lay it to ordinates first.

Stretch a cord from point of frog to the toe of switch, see Fig. 8, and mark its center and quarter points. Spike the center to an ordinate of seven inches, and each of the quarters to an ordinate of $5\frac{1}{4}$ inches and you will have the true line of the lead curve.

As soon as the rods are put on the slide rails and the main track is in line, the switch stand should be bolted to the head block and connected to the rails. The gauge rail of the siding should be spiked to an accurate gauge the full length of the frog, the same as on the main track. But the curve beyond the frog may be allowed to vary a little from true gauge to prevent a kink showing opposite the frog, as would be the case if the whole turnout was spiked to accurate gauge. Next lay down the guard rails opposite

the frog on each side, secure them to place and the switch is ready for use.

If it is a point, instead of a stub switch, the method of proceedure is nearly the same. As the split rails are laid tangent to the curve, the degree of curve and ordinates of the lead will be slightly increased, and should be taken from table 11, if you are not furnished with plans from engineering departments. To make the stock rail for a split switch, cut a small piece out of the flange of the rail where you wish the angle, and bend it almost in the proportion of *one in forty*. This angle should be far enough ahead of the points to make gauge just ahead of points ½ inch wide.

"SPLIT" OR "POINT" SWITCHES.

3. In order to have an unbroken bearing for car wheels on the track rails, the "split," or point switch was devised. Fig,s. 9 and 10, show these switches in their simplest form. Fig. 9, shows the switch set for side track. Fig. 10, shows it set for main track. The rails, A B and G D, called "stock rails," are continuous and spiked their full length, the point rails, E and F, are usually fastened at their heels, H H, by fish-plates to the lead rails. The heels, in the split switch, are in the places occupied by the toes in the stub switch, or at head block. The split rails are generally fifteen feet long for all turnouts; it

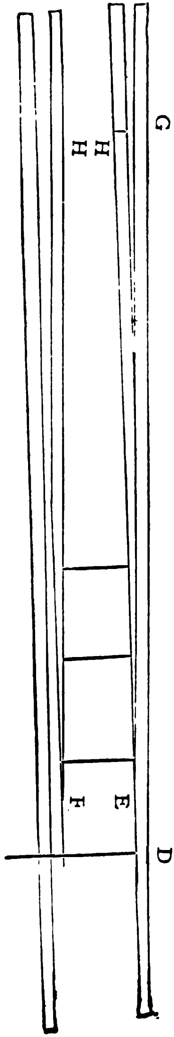


Fig. 10.

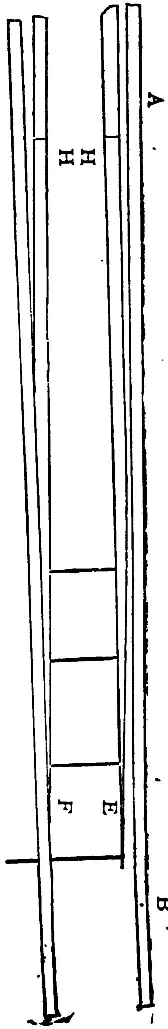


Fig. 9.

gives the best results, combining strength, ease of handling, and economy of manufacture(a thirty foot rail makes two.) As a rule they are straight, and planed, so that they bear against the rail six or seven feet. The throw of the point is about $4\frac{1}{2}$ or 5 inches, and the clear space at the heels between gauge lines is about the same distance.

By introducing a spring or other device in the switch stand, a split switch is sometimes made a safety switch, so that when they are set against a train trailing them, the wheels will push the points aside and leave an unbroken rail for the wheels.

The first cost of a point switch is more than a stub switch, but the split switch is more economical to maintain and safer, making it the cheaper in the end. There can be no question that it is superior to the stub switch, and is fast superceeding it all over the United States.*

TO CHANGE A STUB TO A SPLIT SWITCH.

4. The attachments necessary to make the change from a stub to a split switch, are as fol-

*There is no necessity for using short guard rails just ahead of the points in a split switch. There is no elements of safety existing in the guard rail, when the throw of switch is more than four inches, and when guard rails are used as a protection against wear on the points. The saving effected, will rarely compensate for the use of so much extra material.

lows: Two rails, generally 15 feet in length, with a part of the top and side of the ball of the rails at one end planed off to a point, hence the name point or split rails.

Next: There are four cross rods which are used to connect the two split rails, and are bolted to the rails either at the flange or through the web of the rails. These rods are generally numbered from the head rod back, the head rod number one, besides connecting the split rails are also arranged to be connected to the switch stand and moves the switch. The other rods must then be placed in the order indicated by their number.

There are also wrought iron plates furnished, which are placed along on the top of the switch timbers under the split rails to enable them to slide over the flange of the main rails and lay up close against it. When the switch is thrown to either side, four of these wrought iron plates have an offset in them. The thick part is placed under the split rail and the thin end reaches out under the main rails. Two of these plates are placed on each side of the track and one on each side of the head rod. The other plates are spiked down on the timbers further back from the point with their end under the split rails and close up against the inner flange of the main rails.

When the throw of the split switch is the same as the stub switch, the same switch stand will do

for either. But if the split switch is to have a different throw, to comply with a standard, the switch stand must be adjusted to throw the switch a proper distance. The difference of half an inch in the throw of a switch stand, or the length of the cross rods will make an inch difference in the gauge of track at the points.

When you are ready to begin the work of changing the switch, lay down the two split rails upon a couple of pieces of timber, close to the track in the same position they would occupy in track and let one of your men bolt the cross rods to the split rails securely, measure with your tape line fourteen and a half feet from the head chair joint of the stub switch along the moving nails and mark this as the place where the head rod of the split switch will come, you can then remove a couple of ties, and if a double head block is required, you can put them in, one on each side of where the head rod will be, with a space of about four inches between them. If only one head block is necessary, put it on whichever side of the head rod that will best accommodate the switch stand. While some of the men are doing the work specified, others may be removing the head chairs, tie rods and head block and other connections of the stub switch.

One of the side rails of the stub switch, which is on the side track side of the main track, is named the stock rail in a split switch. This rail should be taken out of the track and bent at a

point a short distance ahead of the point of split rail. It should then be put back in the track and bolted to the main rail at one end, and to the outside rail of the side track at the other end. This rail should be bent carefully, so that it will be perfectly straight from the point of split rail, back to a point square with the heel of the split rail. The opposite joint in the main track, should then be secured with bolts and fastenings. Next, lift the split rails and lay them into the track, connecting their heel ends, one with the rail leading to the frog the other with the main rail on the side track side, and as soon as you have spiked the tie plates along under the split rails and made connection with the head rod and switch stand, the switch is complete.

As an additional precaution against track spreading enough to prevent the points laying close to the main rails, a rail brace may be spiked down outside the main rails, just ahead of the switch points. The heel of a split switch is at the head block of a stub switch, and the instructions here given, are based on the assumption that the length of the stub switch lead from the head block to the frog point is correct, before changing the switch.

The heel of the split switch, should be square with the main rail, and the distance between gauge lines should be the same on both sides of the track.

DESCRIPTION OF TABLE I.

5. Turnout Table I gives all the data necessary for lay out turnouts, whether single or double, from straight track or curves, and for any frog number. In the first column are given frog numbers, increasing by halves from 5 to 12; the angles corresponding to them in the second column. In the third column will be found the distance, C F, Fig. 8, from point of frog to head block or heel of switch. In the 4th the length of switch rail for a 5 inch throw. Column 5, 6 and 7 show respectively the tangent, radii and degree of curvature. Column 8 and 9 show respectively the middle, and quarter ordinates of the chord, C F, Fig. 8. Column 10 and 11 gives a rate of change in the middle and quarter ordinates per degree of main track curve, and is to be added or subtracted respectively, as the turnout is laid with or against the main track curve. Column 12 gives the distance from head block to middle frog point within throw switches. Column 13 and 14 shows the middle frog angles and their corresponding numbers.

TABLE I.--Switch Rails, Curved; Gauge 4 Ft. 8 1-2 In.; Throw of Switch 5 Inches.

NUMBER.	FROG ANGLE.		CHORD ON OUTER RAIL FROM HEAD BLOCK TO POINT OF FROG.		LENGTH OF SWITCH RAIL STUB.		TANGENT.		RADIUS.	DEGREE OF CURVE.		MIDDLE ORDINATE MAIN TRACK STRAIGHT.	QUARTER ORDINATE MAIN TRACK STRAIGHT.	CHANGE IN MIDDLE ORDINATE PER DEG. OF CURVE--MAIN TRACK.	CHANGE IN QUARTER ORDINATE PER DEG. OF CURVE--MAIN TRACK.	HEAD BLOCK TO MIDDLE FROG POINT.		ANGLE OF MIDDLE FROG.		MIDDLE FROG NUMBER.
	Deg.	Min.	Ft.	In.	Ft.	In.	Ft.	In.	Feet.	Deg.	Min.	In.	In.	In.	In.	Ft.	In.	Deg.	Min	
5	11	25	33	4	14	0	23	9½	235 40	24	32	7	5¼	9/32	7/32	19	4¼	16	08	3.527
5½	10	23	36	7½	15	5	26	1¼	284 83	20	13	7	5¼	11/32	¼	21	3½	14	41	3 881
6	9	32	39	11	10	9¾	28	5½	338 98	16	58	7	5¼	13/32	5/16	23	2¼	13	28	4.235
6½	8	48	43	2½	18	2½	30	9½	397.83	14	26	7	5¼	15/32	⅜	25	1½	12	26	4.589
7	8	10	46	6	19	7½	33	1½	461.38	12	27	7	5¼	9/16	17/32	27	0½	11	33	4.943
7½	7	58	49	9½	21	0¼	35	5¾	529 65	10	50	7	5¼	21/32	½	28	11¾	10	47	5.297
8	7	09	53	1	22	5	37	9¾	602.62	9	31	7	5¼	¾	9/16	30	10¾	10	06	5.651
8½	6	44	56	4½	23	9¾	40	2	680.31	8	26	7	5¼	13/16	⅝	32	10	9	31	6.005
9	6	22	59	8	25	2¾	42	6	762 70	7	31	7	5¼	15/16	11/16	34	9	8	59	6 359
9½	6	02	62	11¾	26	7½	44	10¼	849.79	6	45	7	5¼	1 1/32	25/32	36	8	8	31	6.713
10	5	44	66	3¼	28	0	47	2½	941.60	6	05	7	5¼	1 5/32	⅞	38	7¼	8	06	7.067
10½	5	27	69	7	29	5	49	6¾	1038.11	5	31	7	5¼	1 ¼	15/16	40	6¼	7	43	7.420
11	5	12	72	10½	30	10	51	10¾	1139 34	5	02	7	5¼	1 ⅜	1 1/32	42	5½	7	22	7.774
11½	4	59	76	2¼	32	2¾	54	3	1245.27	4	36	7	5¼	1 ½	1 ⅛	44	4½	7	02	8 128
12	4	46	79	5¾	33	7½	56	7¼	1355.90	4	14	7	5¼	1 21/32	1 ¼	46	3¾	6	45	8.482

DESCRIPTION OF TABLE II.

6. Turnout Table II is calculated for a point rail 15 feet long, laid tanget to the turnout curves at its heel. The angle in the stock rail is 1 degree and 26 minutes or the proportion of 1 in 40. It will be noticed that the degree of curvature is slightly increased, and the total head shortened.

In these tables where distances are given to frog points, it is to the true point, and the difference between the true and blunt point is to be added each time. But it is not necessary to cut a rail when putting in a switch if the total length is but a few inches more or less than the leads given in the table.

TABLE 2.--Ordinates and Chords to Locate Turnout Rail Between Point of Frog and Point or Split Switch; Gauge 4 Ft. 8 1-2 In.; Switch Rail 15 Ft. Long; Switch Angle 1 Degree, 25 Minutes.

Number.	Frog Angles.		Chord From Frog to Heel of Switch.		Radius.	Degree of Curve.		Middle Ordinate Main Track, Straight.		Quarter Ordinate. Main Track-Straight.		Change in Middle Ordinate per Degree of Curve—Main Track.		Change in Quarter Ordinate per Degree of Curve—Main Track.	
	Deg.	Min	Ft	In.		Deg.	Min	Ft.	In.	Ft.	In	Ft.	In.	Ft.	In.
5	11	25	38	4	217.85	26	32	0	10	0	7½	0	[illegible]	0	0[illegible]
5½	10	23	41	8	264.53	21	47	0	[illegible]	0	7⅜	0	0[illegible]	0	0[illegible]
6	9	32	44	11¼	315.98	18	13	0	9[illegible]	0	7⅛	0	0[illegible]	0	0[illegible]
6½	8	48	48	5⅝	372.42	15	26	0	9[illegible]	0	7	0	0[illegible]	0	0[illegible]
7	8	10	51	3⅛	433.83	13	14	0	9[illegible]	0	6¾	0	0[illegible]	0	0[illegible]
7½	7	38	54	4	500.43	11	28	0	8[illegible]	0	6⅝	0	0[illegible]	0	0[illegible]
8	7	09	57	4	572 21	10	00	0	8[illegible]	0	6½	0	0[illegible]	0	0[illegible]
8½	6	44	60	3¼	619.43	8	50	0	8[illegible]	0	6¼	0	0[illegible]	0	0[illegible]
9	6	22	63	1⅞	732.36	7	50	0	8[illegible]	0	6⅛	0	1[illegible]	0	0[illegible]
9½	6	02	65	11¾	821.08	6	59	0	7[illegible]	0	6	0	1[illegible]	0	0[illegible]
10	5	44	68	9	915 65	6	16	0	7[illegible]	0	5¾	0	1[illegible]	0	0[illegible]
10½	5	27	71	5½	1016.50	5	38	0	7[illegible]	0	5⅝	0	1[illegible]	0	1
11	5	12	74	1½	1123.88	5	06	0	7[illegible]	0	5½	0	1[illegible]	0	1[illegible]
11½	4	59	76	8⅞	1237.88	4	38	0	7[illegible]	0	5⅜	0	1[illegible]	0	1[illegible]
12	4	46	79	3½	1358.44	4	13	0	6[illegible]	0	5⅛	0	1[illegible]	0	1¼

FROGS.

7. A frog is a contrivance for allowing the wheels of a car to cross a rail.

Fig. 11 is an outline diagram of a frog. The triangle, A C E, is tongue. C E is the heel of the tongue. The channel at K is the mouth. Its narrow part, F H, is the throat. The wings, F G, and H I, support the treads of the wheels from the point, B, to the throat. L M is the heel of the frog. The angle is the divergence of the lines, A C and A E. The intersection of the lines at A is the true point of the frog. As this point is too weak for service, it is rounded off where the tongue is about one-half inch wide. The frog number is the ratio of the base, C E, to the perpendicular, A D, the length of the point. Thus, if the length, A D, be 7, 9 or 10 times C E, the frog is called a No. 7, 9. or 10 frog.

Crossing frogs are used where one track crosses another. They are generally supported by long ties for the smaller angles, and heavy tramed timbers for the larger angles. The nearer the angle approaches 90°, the more difficult they are to maintain, owing to the wheels dropping into the space left for the other road. Where one road is double tracked, the frogs are difficult to keep in line, owing to the tracks of the double line often creeping in opposite directions.

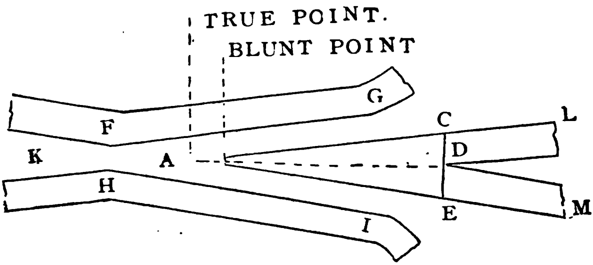


Fig. 11.

LAYING FROGS IN TRACK.

8. When putting frogs into a track care should be taken to have them in a true line and level with the track rails which are connected to them. The gauge rail, opposite the frog should be put to a perfect gauge for the full length of the frog. In sharp turnouts, when all of the track at the frog and running each way from it is put to a perfect gauge, there is left opposite the frog an ugly looking kink in the gauge rail. This is caused by the track at the frog being necessarily straight. It does not correspond with the curve line which runs each way from the frog. This can be remedied without injuring the track by spiking the curve track enough wide gauge to have it line true with the track at the frog. To have a perfect gauge along the frog, the gauge should be tried at each end of the frog and again about six inches back of the point of frog. When long frogs are used and there is

very little curve in switch lead, the track can be spiked to a proper gauge and the kink, spoken of as showing at the frog, will not be perceptible. Foremen should see that frogs are not allowed to fill up with ice or snow in the winter season and when foot guards for the protection of trainmen are provided, section foremen should see that they are always kept properly in place to prevent any liability of accident.

LENGTH OF FROGS.

9. Long frogs and long switch leads are the best where it is practicable to use them, the rails in short switch leads soon wear out. If the switch lead is long, the saving effected in the wear of the rails and rolling stock more than compensates for the loss of the extra amount of steel in the long frog when worn out. A valuable feature in a frog is to have it of such a length that very little cutting of rails is necessary when putting in a new switch. Where full length rails can be used in a switch it saves time, labor and material.

GUARD RAILS.

10. The guard rail at switches is used to prevent the car and locomotive wheels from crossing the point of the frog when trains are passing

through the switch. The length and shape of a guard rail adopted as the standard should be used with all frogs in service on the same road. No guard rail should exceed ten feet in length, except when a piece of rail is used for the purpose which happens to be a few inches longer, when it would not pay to cut off the surplus. A shorter guard rail than the length given above may be used, but it should be secured solidly, beyond the possibility of displacement. Enough of the middle of the guard rail should be spiked down parallel with the track rail, opposite the point of the frog, to cover the distance from where the side wings separate at the throat of the frog, back to the frog point. This is an ample protection. The guard rail may be secured by spiking it to the ties, and by passing a bolt through the guard rail and track rail at each side of that part which is parallel with the track rail, leaving between the two rails a wheel channel. This makes it unnecessary to use braces except as additional precaution. Iron spools or washers may be used on the bolts between the webs of the guard and track rails, to regulate the width of the wheel channel, which should never be more than two inches on a standard guage track.

The extreme ends of the guard rail should be spiked to the ties at a distance of four inches from the track rail. But may be laid an inch closer to track rail if the end is bent round to-

wards center of track. This will give the wheels an easy and gradual approach to the narrower space where the rails are parallel. Guard rails should not be sprung to the place with the track spikes but should be bent to the proper shape before being laid.

When guard rails are made in the company's shops their ends should be heated and hammered down to form a gradual approach or slanting surface from the base of the rail, where it rests on the ties, to the top. This would prevent brake beams, chains, or snow plows, etc., from catching on the end of the guard rail and tearing it out of place. It would be well to take the same precaution with the ends of guard rails which cross bridges or go around curves inside the rails on main track.

IF THERE IS NO STANDARD.

11. Where there is no standard guard rail used on a railroad, and the track foremen have to provide the guard rails wanted, when they put in a new switch, the piece of rail which is cut from a full length rail to let in the frog will do to make a guard rail, and when long enough should always be used for a guard rail in preference to cutting another good rail. Very long guard rails are a waste of material and fastenings, which could be put to better use at some place else on the road. Long guard rails are always difficult

to keep in place, especially on sharp turnouts, because where ten, twelve, or fifteen feet of guard rail is spiked down parallel with the track rail, as is often the case, the drivers of an engine or the wheels of a car truck are all at one time in the narrow wheel channel, and cannot curve properly. They therefore wrench and twist the guard rail, while the wheel base is held in a straight line. This wears the rolling stock, besides making it more difficult for an engine to pull a train through the switch. The width of the wheel channel between the guard rail and track rail should never be more than one eighth of an inch wider than the wheel channel through the frog. If the wheel channel between the guard rail and track rail is one quarter inch or more wider than the frog channel, car wheels with sharp flanges are very apt to climb the frog point, and run off the track, especially if the guard rail side of the track is the highest. The frog point always shows wear on whichever side the guard rail is too wide.

To make a guard rail properly, take a ten foot piece of iron or steel rail, and bend it uniformly from the central part towards the ends, until a cord stretched along the face of it shows a middle ordinate of two inches from a point on the gauge side of the rail at its center to the middle of the cord. It will then be ready for spiking down and need not be sprung at any place.

SWITCH TIMBERS.

12. As there is considerable difference in the standards for bills of switch timbers on the different railroads, the following rules will be useful to track foremen.

Rule to ascertain the number of pieces needed for any switch lead. Find the distance from the head block to the point where the last long tie will be used behind the frog. Reduce this distance to inches, and divide it by the number of inches from the center of each tie to that of the next one. This will give the number of ties wanted.

EXAMPLE: Distance from the head block to the last long tie behind the frog, 55 feet; reduced to inches, 660 inches; distance from center to center of ties, 20 inches; number of ties required, 33.

The first three of these ties next the head block may be common long oak cross ties, and as 9 feet is the shortest piece sawed square for a switch tie, and 14 feet the longest for a single throw switch, the other 30 pieces may be divided up, when ordering the different lumber lengths, as follows:

5 pieces,	9	foot	long	5 pieces,	12	foot	long
5 "	10	"	"	5 "	13	"	"
5 "	11	"	"	5 "	14	"	"

When odd lumber lengths of switch timbers are not furnished, then order double the quanti-

ty, 10, 12 and 14 foot pieces. In large yards where there is very heavy traffic, switch timbers should not be laid more than 8 or 9 inches apart. A switch that is well put in with timbers under it 8 inches apart will wear out in the rails without needing any repairs in the surface, but when ordering switch timbers foremen should always be governed by whatever standard is in force on the road.

TO CUT SWITCH TIES THE PROPER LENGTH TO LINE.

13. RULE.—Measure the length of the tie next the head block and also the length of the last tie behind the frog. Find the difference in inches between the lengths of the two ties, divide this amount by the number of ties in the switch lead, and the quotient should be the increase in length per tie from the head block towards the frog, to have the ties line evenly on both sides of the track.

EXAMPLE: We will suppose the tie next to the head block to be 8 feet 6 inches, or 102 inches in length, and the last tie behind the frog, 14 feet, or 168 inches in length. The difference in the lengths of these two ties is 5 feet 6 inches, or 66 inches; dividing by 33, the number of ties, gives two inches as the amount that each tie must be longer than the last. Section foremen will find this rule valuable in many cases, especi-

ally when putting in a cross over from one track to another. There is nothing gained by having switch ties project beyond the proper line of track. They cause trouble in raising track, are unsightly, and labor is only wasted in tamping up the long ends. The switch ties may be cut off the proper length and numbered with chalk, and the line side marked for the rail flange before put in the track. The work can be done in that way quicker and better, and the unnecessary labor of digging out for and tamping up long ends can be dispensed with.

TAMPING SWITCH TIES.

14. When a switch track has been raised up to surface the track at that place, the switch ties, along under the frog and main track rail, should be tamped up first. The long ends of switch ties should be tamped up last, and then not so solid as those under the frog. Tamping bars should be used in tamping up a switch, and special care should be taken to make the ties as solid as possible under the frog. A switch is all the better if the frog is a shade higher than the balance of the switch. Head blocks should also be a little stiff; a quarter of an inch higher than the level of the track rails will do no harm, and will soon come down to level on a stub switch. If the out ends of switch ties are tamped up first, unless the timbers are very large, they will sag down in

the center and the ends will turn up, especially if a train is allowed to pass over the switch before the ties are tamped throughout their lenght.

A set of switch timbers may be put into a mud track very quickly, and with little or no tamping, by the following method. Remove all the old timbers except a few to support the track rails. Raise the rails on the supporting ties about a quarter of an inch higher than the track surface, and level them with a spirit level. Clear away a bed for the timbers equal to their depth, and spread a little loose dirt on it, then pull in the timbers keeping their upper surface close up to the rails and each timber level throughout its length until it is in place.

PUTTING IN DOUBLE THROW SWITGHES. *

15. The length of switch ties in a three-throw switch is found by doubling the set for a single turnout, and subtracting the length of the standard cross-tie. When putting them in the track,

*There is a great deal of time, labor and track material saved in the use of three throw switches, or what is called double throw switches. They are also convenient at points where track room is scarce.

If a switch comes on an embankment, the amount of grading is much less for a three throw switch, than for two single throws. Freight trains can be switched and made up in station order in about half the time required with single switches. And the use of threes throw switches at way stations enables freight trains to do their work quicker and make much better time in getting over the road. J. K.

measure the length of each tie and draw a chalk line across the middle; mark also the middle of the gauge. Lay the gauge on the main track, and as each tie is put under the track, see that the chalk mark across the middle of the tie comes directly under the middle of the gauge. The proper angle, number and distance from the head block of the middle frog is given in table No. 1. The number of the middle frog is found by multiplying the number of the principal frogs by the decimal .707, and its distance from the head block is found by dividing the radius by twice the middle frog number, and subtracting the length of switch rail. If there is no frog of the angle corresponding to the angle of the principal frogs at hand, select one as nearly like it as possible, and calculate its distance ahead of the head block. The line of the lead rails will then be a compound curve.

DERAILING SWITCHES.

16. Fig. 12, illustrates a method for derailing cars, and is used in cases where extra precautions are required to prevent cars from accidentally running out of the siding upon the main track.

It consists of a head block, a low switch stand with a connecting rod attached to the outside rail, C D, near the end of the curve on the siding, and a head chair, E, to receive the ends of

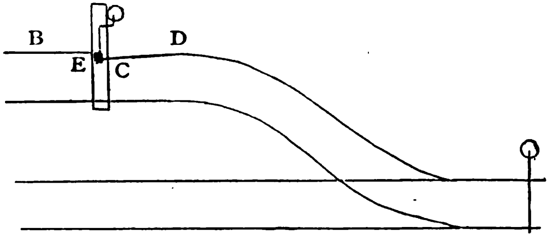


Fig. 12.

the rails, B and C. Connection is broken by throwing the switch which moves the moving rail, C D, inward. This guides the derailed car away from the main track. When putting in this derailing switch, drive a row of spikes against the inside flange of the rail, C D, when set for derailing; and place rail braces on the outside to support and keep the rail in place, when set for the side track. It is good policy to use good sound oak ties, spaced not more than eight inches apart under the moving rail. It presents a smoother surface for the derailed car than ties spaced the ordinary way, and prevents the wheels from sinking between them.

This switch has less parts and is more economical than a derailing switch with two moving rails connected with rods. When properly secured with a hinge joint or pivot, and working on a solid plate throughout its length, a much shorter sliding rail can be used. A point rail can be used, and the end of the rail at B can be slightly

turned outward, but there is no advantage in its use except to make it work lighter when automatic connection is made with the main track switch.

When setting up switch-stand, have the target show danger, when the switch is set for derailing.

TURNOUTS FROM CURVES.

17. In turnouts from curves, the lead distance is practically the same as turnouts from a straight track. The degree of curve of the turnout is approximately increased by the degree of the main track curve, when the turnout is *with* the curve; and decreased the degree of the main track curve, when the turnout is *against* the curve. In turnouts against curves, when the degree of the main track curve is the same as the turnout curve corresponding to the frog, the lead will be almost straight; when greater, the lead curve will deflect the same direction as the main track curve. As curves for ordinary frog numbers are sharp, avoid as much as possible turnouts from the inside of the curve.

The ordinates of the chord Fig. 8 will be increased a certain rate per degree of main track curve, when the turnout is laid with the curve; and decreased the same rate per degree when the turnout is laid against the curve.

EXAMPLE. A turnout with a curve; degree of main track curve 2 degrees; frog No. 9. Here degree of curve of turnout= 2 deg. + 7 deg. 31 m. = 9 deg. 31 m. Middle ordinate=15-16×2=1 7/8 inches; added to 7 inches=8 7/8 inches.

Quarter ordinate=11-16×2=1⅜ inches; added to 5¼ inches =6⅝ inches.

EXAMPLE.—A turnout against a curve; degree of main track curve 4 deg.; frog No. 8. Here degree of turnout= 9 deg. 31 m. — 4 deg. = 5 deg. 31 m. Middle ordinate= ¾×4=3 inches; subtracted from 7 inches=4 inches. Quartes ordinate=9-16×4=2¼ inches; subtracted from 5¼ inches=3 inches.

TO REACH A SIDE TRACK WITH A REVERSE CURVE BEHIND THE FROG.

18. The simplest and most economical method for laying out a side track, along which buildings are located, is to continue the *lead curve* back of the frog to a point which would be midway between the tracks if they paralleled each other. Then reverse the curve and join it with the tangent on side track at a point the same distance from the reversing point as the switch point is in the opposite direction, as shown in Fig. 13.

RULE.—When laying out the side track parallel with the main track, continue setting center stakes as if for a tangent from A to B, Fig. 13, making the latter point come at right angles with C, which is the point of switch already located in main track.

Then measure accurately the distance between the stakes, B and C, and set a stake at D, midway between them. The point, R, may be found by running a line of stakes from D to F, parallel with main track.

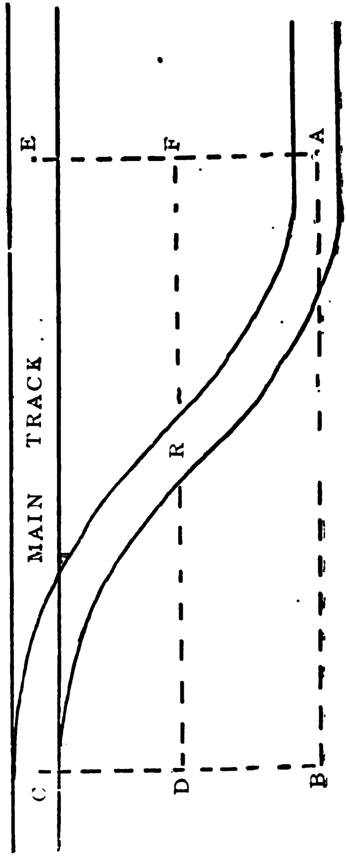


Fig. 13

After you have laid the switch and side track curve as far as R, then measure the distance, R F, making it equal to the distance, R D, and set the stake at right angles with F at A, which will mark the end of curve on the side track. A stake may be set at E, for convenience in locating the point, F, and the angle, F A, or C D, may be squared fairly well by using a common track guage, laid across the rails at C or E, on the main track. There is a great deal of good track room wasted, where side tracks are put in with a long tangent behind the frog and the method here illustrated has advantages where land is valuable, and it also economizes material. But I would not recommend the use of curves above 6 degrees. Because the track is not as safe. Is more difficult to keep in repair, and the rails wear out much sooner on sharp curves.

ROUND HOUSE TRACKS.

19. To locate the frog point for round house tracks, find the distance between and including the tops of the two adjoining rails in two stalls of the house. Any point where you have laid the rails will do to measure this distance; near the house doors is a good place. We will suppose this distance to be twelve feet.

The frogs about to be used are four feet or 48 inches in length from point to heel, and the extreme width of the heel is, say, eight inches.

By dividing the length, 48 inches, by the width of the heel, you find the frog to be a number six, as the rails deflect from each other one inch in six, or one foot in six feet, two feet in twelve, four feet in twenty-four, eight feet in forty-eight, and twelve feet in a distance of seventy-two, etc.

This shows that the point of frog must be located seventy-two feet ahead from the point where measurements were taken, at which place the rails were twelve feet apart. But to locate the frog point accurately, two lines should be stretched along the gauge side of the two track rails running out of adjoining stalls. Carry them in a straight line to the turn table. This will cause them to cross each other where the frog point should be located. Stretch the lines tight and lay the frog down under them and spike it to the ties.

In order to get the true point of a frog the lines should touch the gauge side of it throughout its full length, and the correct point is where the lines cross each other, not the end of the steel point. After the frog is located the rail connections behind it may be made, and if the other frogs are of the same angle as the first one, they should all be placed the same distance from the turn table and spiked accurately to gauge. But if the frogs are of different angles (which should not be the case) they will need to be laid at different distances from the turn table proportionate to their angles.

ANOTHER METHOD.

20. The frogs which lead from the turn table into the round house may also be located in the following manner. Draw two cords along the gauge side of the nearest rails in two adjoining stalls and cross the lines before reaching the turn table. Then stretch the cords tight, holding the end of each at the middle of one of the track rails on the center of the turn table. Swing the turn table into line with one of the stalls, and while it is held in this position mark the place where the two lines cross each other. The place so marked will be the point of your first frog. The other frogs will all be right if placed the same distance from the turn table as the first one, and spiked accurately to gauge.

CROSS OVER TRACKS.

21. To put in a cross over from one track to another where the work has not been laid out by an engineer:

RULE.—Put in the first frog and switch lead complete on one track. Then sight a straight line along the gauge rail from opposite the point of frog, which you have just put in track, to the nearest rail of the adjoining track. Where the line crosses the rail is where the point of the next frog ought to be located to complete the

crossover if both frogs are of the same angle.

Another method when same size frogs are used. Take the difference between the gauge lines of the inside rails and the gauge of track, multiply the remainder by the frog number, and the result will be the distance measured along the track, Fig. 14, as D C, or A B.

Ex.—Distance between gauge lines of middle rails 7 ft. Frog No. 9. Distance between frog points equals 7 ft. less 4 ft. 8 in's. =2 ft. 3½ in's.; 2 ft. 3½ in's. ×9=20 ft. 7½ in's.

If frogs of different angles are used in a crossover, say a No. 10 and a No. 7, figure by rule the distance required for a pair of No. 10 frogs, also the distance for a pair of No. 7 frogs. Then add half the distance of the number 10 frog to half the distance of the number 7 frog, and the total amount is the distance required between frog points.*

This principle will apply correctly to any case of variation in frog angles.

The lead curves, corresponding to the frog angles in a crossover, should be carried a proper distance beyond the frogs until they meet and reverse between the tracks.

TABLE OF DISTANCES BETWEEN FROG POINTS IN CROSSOVER TRACKS.

22. The following table shows the distance

*Sharp curves should not be put in a crossover except when it is absolutely necessary to do so, in order to conveniently locate a switch.

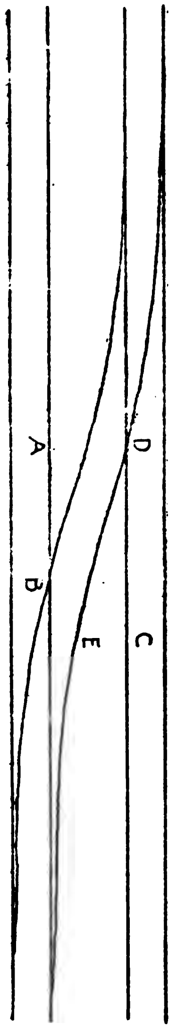


Fig. 14.

between frog points diagonally in any crossover track put in with the frogs mentioned in the table, for distances between tracks of 7 to 15 feet. Where the distance between two tracks is greater than 15 feet, foremen can calculate the distance between the frog points by the rules preceding this table:

Numbers of Frogs.	DISTANCE BETWEEN TRACKS.								
	7 ft	8 ft.	9 ft.	10 ft.	11 ft.	12 ft.	13 ft.	14 ft.	15 ft.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in	ft. in.	ft in.
1 to 5.........	11 6	16 6	21 6	26 6	31 6	36 6	41 6	46	50 6
1 to 6.........	13 6	19 9	25 9	31 9	38	44	50	56	62
1 to 7.........	16	23	30	37	44	51	58	65	72
1 to 8.........	18 4	26 4	34 4	42 4	50 4	58 4	66 4	74 4	82 4
1 to 9.........	20 8	29 8	38 8	47 8	56 8	65 8	74 8	83 8	92 8
1 to 10.........	23	33	43	53	63	73	83	93	103
1 to 11.........	25 3	36 3	47 3	58 3	69 3	80 3	91 3	102 3	113 3
1 to 12.........	27 6	39 6	51 6	63 6	75 6	87 6	99 6	111 6	123 6

As the above table gives the distance in feet from a point on the gauge rail opposite the point of the first frog to the point of the frog in the next switch of the crossover track, the length of the second frog from point to heel must be deducted from the distance given, when preparing the rails which cross between the tracks.

A reverse curve can be made longer in the crossover between tracks when they are very far part, and there is not room to put it in the regular way.

PARALLEL TRACKS.

23. Where a track runs diagonally from a main track and it is used to throw off switches from, and if the tracks from such switches is to run parallel to the main track, inexperienced foremen find it difficult to locate the frog for a new track so as to have straight track behind it. The place for the point of frog for a new track can be easily located by the following method:

RULE.—Sight a line with stakes where you find the outside of the rail should come back of the frog on your intended track, and parallel to the main track, or the nearest track which runs in the same direction. Then with stakes carry the line perfectly straight until it crosses the first rail of the diagonal track. This is where the frog point should be placed for the new track.

The above rule will always work well where the two tracks separate behind the frog at an angle corresponding to the angle of the frog, but should it be necessary to maintain two tracks, running from a switch, which diverge at an angle that will not suit the frogs you intended to use, you can ascertain by the method shown in the diagram Fig. 15, what kind of a frog will be needed.

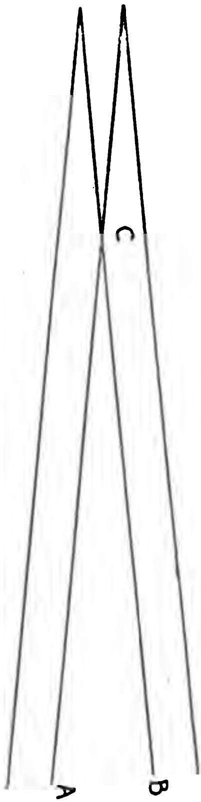


Fig. 15.

HOW TO ASCESTAIN THE KIND OF FROG NEEDED.

24. The lines in diagram represent the rails of two tracks. Measure across between the tracks rails at the points marked A and B, each of which is an equal distance from C, which marks where the rails cross or point of intersection, then measure the distance, C B. Now divide the distance, C B, by the distance, A B, and the result will be the angle of the frog required. Suppose the distance, A B, is twelve inches, and the distance, C B, nine feet, it would require a one to nine frog, or as it is sometimes called a number nine frog. The distance, A B, may be measured where the rails or lines are only six or eight inches apart, but the result will always be the same in proportion to the distance from C to B. Where tracks are to run parallel with each other, it is best to gauge the distance they are to be apart by measuring from the nearest rail of a permanent track adjoining, if in good line, or from the center of the main track in yards.

SPUR TRACKS.

25. Spur tracks should be laid with a view to avoiding any extra switching. Always put in your switch on that end of the spur track which is in the direction in which the loaded cars are to be hauled. This matter does not always receive

the attention it deserves. It is much easier to throw empty cars back upon a spur track than to head an engine in after the loads, and push them ahead to the nearest station to be switched there again. Much valuable time could be saved if all spur sidings could be dispensed with. Time is money in all the departments of a railroad, and to those track men who supervise the laying of any new tracks, especially in yards, I would say, lay all tracks with a view to the most efficient handling of cars. Help the train department all you can. Put a switch at both ends of a track whenever it can be done at a reasonable cost.

TO STRAIGHTEN RAILS IN TRACK.

26. To straighten a kinky rail or one bent latterly without taking it out of track is not a very difficult matter when a trackman understands how to do it. Double spike a tie at each end of the bend in the rail and at the same points have one of the men drive a lining bar firmly in the ground and hold it tight against the rail. Then with a chisel nick the flange of the rail, on the outside of the bent place to weaken it and you can then straighten the rail perfectly with a few good strong blows from a spike mall. Always strike the flange of the rail oftener than the top of it, as it is the most difficult part to bend, and to prevent cutting off your mall handle, if

you strike and miss the flange, slip a piece of a board or plank in between the ties, and let it lay about half an inch below the base of the rail.

This little trick of the trade will save trackmen much annoyance where they are troubled by kinky rails and enable them to keep a good line and gauge on track.

When bending the stock rail for split switches the work can be done easier, and better results obtained by cutting a nick in the flange of the rail, where you want to bend it, before using the sledge or rail bender.

LAYING NEW STEEL.

27. When steel rails were a new thing, and cost several times as much money per ton as they now do, the railroads which purchased them were very careful where they laid them and how they were laid. The track had to be ballasted, smoothly surfaced, and filled up with good, sound ties, especially under the rail joints.

None but the best of trackmen were employed to do the work, and special instructions were issued to the foremen how the rails should be handled and laid in the track; and the correct space between joints at the different temperatures was given, which could not be varied because expansion shims were furnished to be placed between the rails when being laid.

Special provision was made for unloading the rails from cars without bending or twisting them. No kinky rails were put in the track in that condition, and a record was kept of the wearing qualities of each separate lot of steel rails. It was considered next to a sacrilege to cut off the end of a steel rail to make a connection or put in a new switch lead, the iron rail always being cut in preference, or proper lengths of steel being furnished for the switch lead. The results, in most cases, fully compensated for the pains taken when laying steel rails, and most of the railroad men who have had experience doing this work can testify that rails so well taken care of remained in service and lasted almost double as long a time as some of the steel rails laid nowadays.

This in part may be attributed to the inferior qualities of some of the steel rails produced at the present time, some of which will not wear as well as old craw shay iron.

Steel rails have become so common now that all new railroads constructing or old roads relaying their track use nothing else, and on many of these roads (although there may be a pretense to the contrary) the steel is often thrown down on rough grades and run over without ballasting. In fact the policy of those in charge of the work seems to be, in some cases, not to take any better care of the new steel than they would of old worn out iron. Although steel has now become more

common than iron, the regulations for laying it, such as those mentioned in the beginning of this article, should not be altered in any particular. June, July, and August are the best months for laying steel rails in the north and west, because during the summer months the conditions are more favorable for improving the track. The ground is dry and subgrade solid. Ties are all in the track, or on the ground ready to put in. Ballast supplies can be easily reached. There are better facilities for furnishing locomotives and cars to do the work, on account of lighter business on the roads. Last, but not least, the new rails may be laid at a time when there is the least variation in temperature and they are at or near their greatest expansion.

HOW TO RE-LAY IRON OR STEEL.

28. The method most generally practiced by track men, when re-laying iron or steel, is as follows: First, the rails to be laid are ranged out along on the ends of the ties and bolted together, the end of the first rail being perfectly square with a joint in the track where the new and old rails meet. The first new rail should have two spikes driven at the end which goes into track first, to keep it from running ahead of the joint, which often happens in warm weather, or is caused by knocking the other rails endwise against it. If the end of the first rail does run

past the joint before the foreman is aware of it, when laying the rails into track, he can generally shorten the line of rails enough to let the first rail in, by throwing a curve in at some distance from the first rail. The bolts should be kept tight in the new rails so that lining will not affect the spacing. The work of ranging out the new rails and getting ready to lay them into track should be done while trains are running so close together that there is not time to change a very large number at once. The time to put in new and take out old rails is when there is the longest time between the passage of trains over track during the day. Another part of the work in getting ready is to remove from the rails in the track all the bolts and spikes that can be taken out with safety. When everything is ready to lay in the new rails, a part of the men remove all of the spikes remaining in the track on one side of each rail. The inside spikes are generally the ones pulled out except when there is a difference in the width of the flange of the new and old rails, when it is necessary sometimes to pull the inside spikes on one side of the track and outside spikes on the other, or on both sides, in order to have the new iron or steel come to perfect gauge. While a part of the men are pulling spikes etc., another part should be throwing out of place the old line of rails and at the same time more of the men should be throwing in the new line of rails and spiking them into

place. Everything should be kept moving so that when the next train is nearly due there is nothing remaining to be done but making the connection between new and old rails where you intend to leave off, until the next line of new rails is ready to put in. A foreman should always see that the first end of the new iron or steel is bolted immediately after throwing it into track, or it may cause considerable trouble by running ahead of the joint or by contracting, when it is sometimes very hard to get it back to place. When a foreman wants to make his temporary connections to let trains pass, a much better and quicker way than the old way of cutting a rail, every time a connection has to be made is to keep on hand, ready for use, two rails about ten feet long, cut tapering to a point on one end like those in split switches. When you want to make a connection you bolt the blunt end of these rails to the end of the last new rail put in, and lay the point end of short rail close up along the side of the next old rail, holding it to place with a shoe and spiking it to gauge. To put this short rail to gauge it is necessary only to pull or spring the spikes enough to let the end of the old track rail spread a little, and let the point rail to gauge. The use of these two short point rails saves considerable time in making a connection, as a foreman can work his men close up to the time that a train is due, putting in the new rails.

AVERAGE LIFE OF IRON AND STEEL.

29. Owing to the difference in quality and in the amount of traffic over iron or steel rails, it is very difficult to form a correct estimate of the average life of either.

An important item to be considered when figuring the life of track rails is the care they received when first laid, and how they were kept up to surface by the section men aftewards. Rails, that are properly laid and are afterwards kept up to a good smooth surface, will wear and give good service from two to five years longer than rails of the same grade which have only been indifferently cared for. Every year that the life of a rail can be prolonged, it means a saving to the company of the interest for one year on the principal invested, and a proportionate part of the original cost, which is sometimes equal to the difference in value between old and new rails, and in many cases the amount thus saved would pay for the track labor for several years.

Good iron rails have been known to last, in service on the main track of a railroad doing a fair business, eight and nine years, and steel rails fifteen years, but many brands wear out in less time.

When their ends have become battered, rails are of little value in the main track of any road, where there is much business, and the joints

cannot be kept up to a good surface, no matter what kind of ballast is put under them. The only remedy is to saw off the bad ends of the rails and use them in branches or side tracks, and when the rail is battered on both the joint and center, it is only fit for rolling mill scrap. Track foremen should always remember that by keeping a smooth running surface on the rails, is the only way they can demonstrate their superiority as good trackmen. For such men there is always employment and good wages. One of the largest items of a railroads expenses is caused through neglecting to keep a smooth surface on the track joints, either on account of incompetent foremen, or insufficient track forces.

EVEN OR BROKEN JOINTS.

30. There has been considerable discussion by trackmen on the subject of broken or even joints. The majority of track has heretofore been laid with even joints, but there lately have been many opinions expressed in favor of laying the rails with what are called broken joints, which consists in placing the rail joint on one side of the track opposite to the center of the rail on the other side of the track. There are a few points in favor of the latter method which I think are of sufficient importance to be worthy of consideration.

On a curve track where the rails were not bent

before being laid, the broken joint will assist to keep the track in line, because the center of the rail will retain the curve better than the joint; but if the rails are bent to the proper shape before being laid, the true curve line can be preserved as well without broken joints. Laying the rails with broken joints and long angle bars slotted and spiked on three ties will give a greater power to prevent track from creeping than with even joints, because the holding power of the three ties has but one side of the track to keep in place instead of both, as would be the case with even joints. It is also claimed that when the rails are laid with broken joints a better surface can be preserved at the joint, the smooth rail center on the opposite side preventing the car wheels from striking the ends of the rail so hard when passing over it, and this seems to be the chief reason for laying the rails that way.

On the other hand it is handier to lay track with even joints and to repair and surface it. Even joints on a rough track *will remain more level, and trains will ride smoother* over them than would be the case over a track laid with broken joints under the same conditions. But a rough track on any railroad ought soon to be a thing of the past. It might be preferrable to lay the rails broken joints where the track is well ballasted and a sufficient force of men are employed to keep it in good repair, for the reason

that if the track has a good surface on the rails the load over a pair of wheels cannot strike the broken joint with as much force as it would on even joints. It would therefore require less labor to preserve the surface and keep the track in good condition.

HEAVIER RAILS WANTED.

31. The time is coming, I think, when all railroads will use a much heavier rail than the average weight now in use, because the increasing demand for freight cars with greater carrying capacity, and the increased weight of all the locomotives which have been built of late, will force the railroads to improve the track they are to run over, and in no other place can improvement be made to better advantage than in the rails and joint fastenings.

Heretofore the policy of many of the railroads has been to lay in the track the lightest weight of rail that it was possible to run over safely, in order to lessen the cost of construction, without a thought as to the probable cost of keeping up such a rail to surface, after the business of the road increased the traffic over it, and as the weight of their rolling stock gradually increased, the defects of said light rails soon became apparent, and different devices were resorted to in order to strengthen these rails. Very heavy splices were adopted to prevent the ends of rails from bending

or becoming too low for the rest of the track. The number of ties under a rail was increased, hard steel was substituted for iron, and additional track labor was employed to make a first class track with this light rail. But I think I am safe in saying that the result has not given satisfaction in proportion to the extra outlay, and that if this money had been expended in purchasing heavy steel rails, it would have been the more profitable policy in the end.

My ideal of a track rail to fill the present want on first class roads would be a steel rail not too hard, four and one-half inches in height, with a flange base five inches wide, a web not less than three quarters of an inch thick, the ball of a sufficient depth and not less than two and one-half inches traction surface on top. This will aid the pulling capacity of the locomotive and lengthen the life of both the locomotive and car wheels.

The gauge side of the rail should be slightly lower than the outside so as to give the whole surface of the top for the wheel base to rest on, and thus increase the wheel mileage and prevent for a much longer period the wearing of a groove in the wheel thread which is the result generally brought about by heavy wheel loads and narrow headed light rails. A wide rail head, which fits the shape of the wheel thread, will prevent so many wheels being sent to the scrap heap, and weaken the power of the lateral

thrusts which swings the cars so heavily at high rates of speed.

A wide rail base will prevent the rail from cutting iuto soft ties, under heavy traffic, and is a much more economical and labor saving method of disposing of the money which many roads are now investing in tie plates, the best results from which are only obtained on sharp curves, where the tie plate acts as a brace for the outer rail by holding the strain on two spikes instead of one.

The bolt holes in the ends of the rails should be of an oblong form, and the expansion and contraction should be controlled by the ties spiked through slots in the angle bars instead of in the rail flange. A rail such as recommended, would weigh between 80 and 90 pounds per yard and would materially increase the cost over the majority of the sections now in use. But I look on this side of the question, as only a secondary consideration, with a first class railroad. Some track men may differ with me as to the thickness of the web of the rail, which I recommend. But I believe this part of the rail should be made much stronger than it is now, and should not be sacrificed to better other parts of the rail, or to accommodate the shape of the splices. Every track rail should be like a steel bridge, capable of supporting the heaviest rolling stock without showing the slightest depression in the surface, even should the supports be taken away from

under three feet of the length at any point.

Railroads now want a rail which will not yield to the weight of their heavy locomotives and press down into every rotten tie, nor bend over at the joints.

By increasing the size and strength of the track rail, we may lessen the amount of labor necessary to keep up the joints and preserve a good surface on the track. The useful life of the ties is increased, while their number can be reduced in good ballast, and besides a very considerable economy is effected in the wear and tear on wheels and rolling stock, three elements which go far towards compensating for the extra cost of the rails. Figures 16 and 17 are half size sections of a rail which would weigh about 90 pounds per yard.

EFFECT OF HEAVY LOCOMOTIVES AND CARS ON TRACK.

32. It seems to me that railroad officers and manufacturers of railroad equipments, sometimes make grave mistakes when seeking to improve some one department of the service. They overlook the necessities of some other department, or ignore it altogether. For instance, a heavy locomotive was constructed for an eastern railroad, and a paper giving a description of it stated that the greatest part of its entire weight would rest on one pair of drive wheels.

INSTRUCTIONS FOR [illegible]UTTING IN

INSTRUCTIONS FOR PUTTING IN

THE WEIR FROG CO.'S

COMBINATION CROSSING OR SLIP SWITCH

WITH OUTSIDE THROWING DEVICE.

Place the frogs in the track, and connect with filling rails as numbered on the head of each rail at every joint, and line up as usual with frog crossings. The switch-points should then be placed in position, following numbers on head of rail, with the curved switch-rails in the middle of the crossing; having first placed the friction plates in position according to their number, put in the switch bars, and then the curved outside stock rail, spiking same to gauge with the switch-points. After being sure that the crossing is to gauge through the turn-out tracks and the crossing tracks, attach the short connecting rods and the connecting rods with turn-buckles to head rods of switches at each end, in the position shown by cut. Then place the "T" cranks in position at each end, join the connecting rods to "T" cranks, and set the arms of the "T" cranks parallel to the center line of crossing, which will make all switch-points open an equal distance, then spike crank-castings to timbers. Throw outside points over against outside curved rails in the position shown, then attach the long rods with bearing castings to "T" crank at each end, and to stand in the center. If the points thrown by long connecting rod have not the proper throw, they are adjusted by the turn-buckle in this long connecting rod, and the points thrown by shorter connecting rods are adjusted to proper throw by turn-buckle in the long rod on the outside of crossing.

As Manufactured by

THE WEIR FROG CO., CINCINNATI, O.

INSTRUCTIONS FOR PUTTING IN

THE WEIR FROG CO.'S

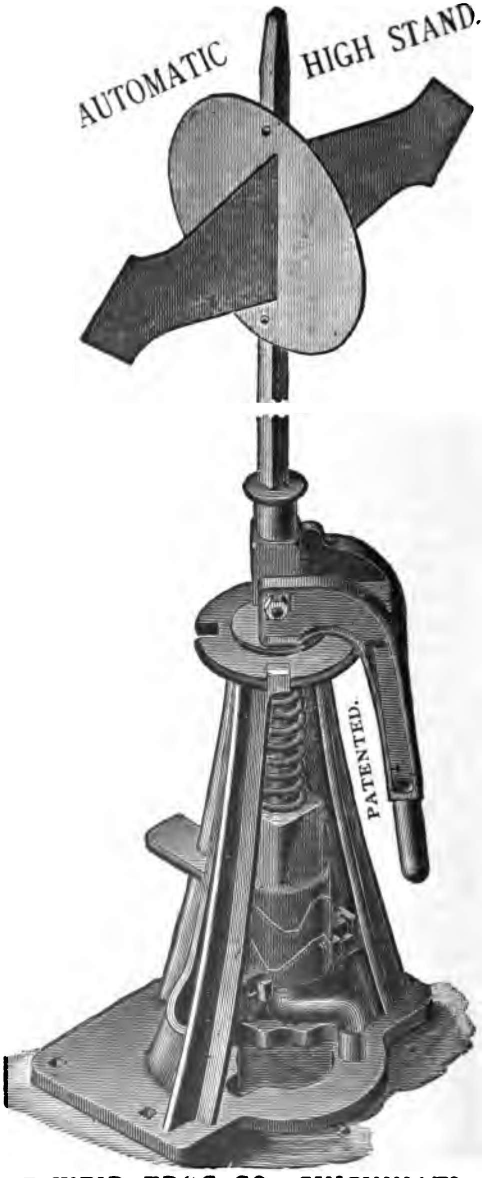
COMBINATION CROSSING OR SLIP-SWITCH

WITH DUPLEX THROWING DEVICE.

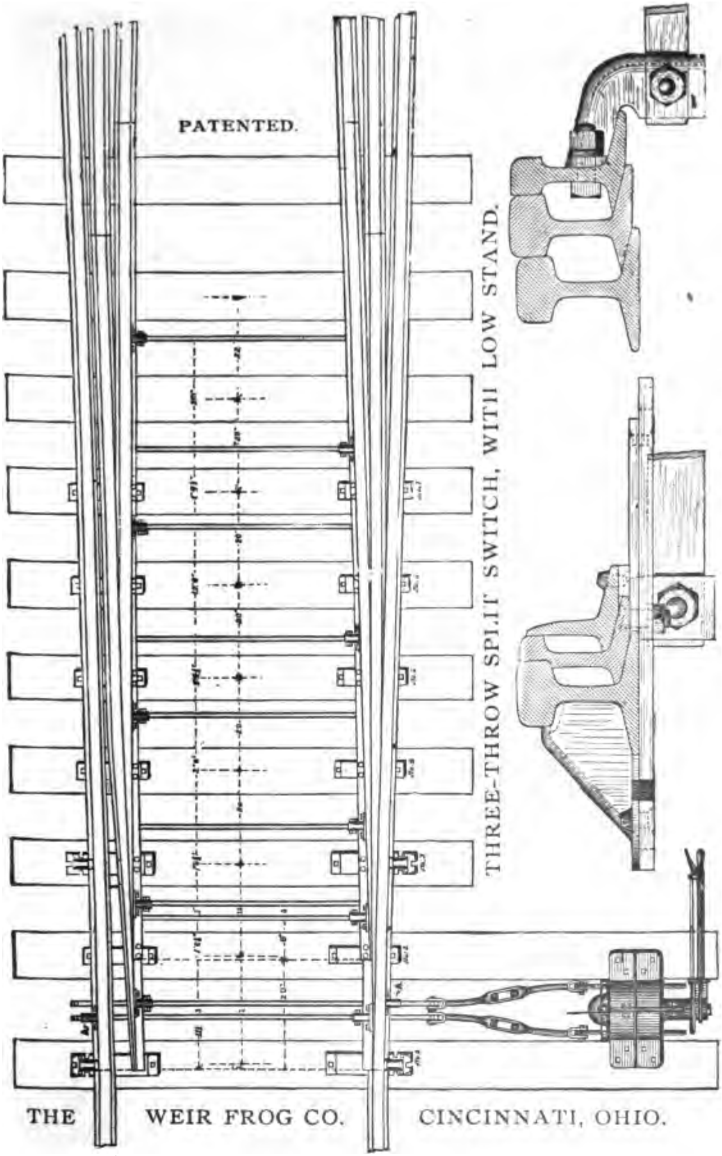
The first thing necessary is to have ties set at proper distances, especially where the friction-plates for the switch-points are to be placed. Then follow numbers on heads of rails at all joints in placing crossing in track; after which spike to proper gauge and line, taking care to place friction-plates, which are numbered (No. 1 goes nearest the point of switch) in proper places on ties. Next place switch-points in position, again following numbers on heads of rails at joints, and put switch-bars, which are also numbered, in their proper places in switches. Next, put middle section of throwing device in place between the center frogs of crossing, connecting rods to be put under the center frog on the side that switch-stand is to be set, and guide-casting that is on the connecting rods must then be bolted into position on center frog, where holes are provided for that purpose. It is then necessary to spike the bearing castings on throwing device to ties, keeping it in the center of the track; after which connect to switch-stand, using one of the two separate connecting rods on each sliding bar of the stand, then spike stand to ties, and remove the temporary bolts from the center of the middle section; after which throw the stand over several times to see that it works freely, and leave in opposite position to what it was before being thrown. Next, place the sections of throwing device in position, follow center punch marks on rods in connecting, and screw up bolts in rods and in lugs at extreme ends to switch-points. When this is done, the outside curved rails should be spiked to gauge, and the switches, when thrown as cuts show, should close up to them.

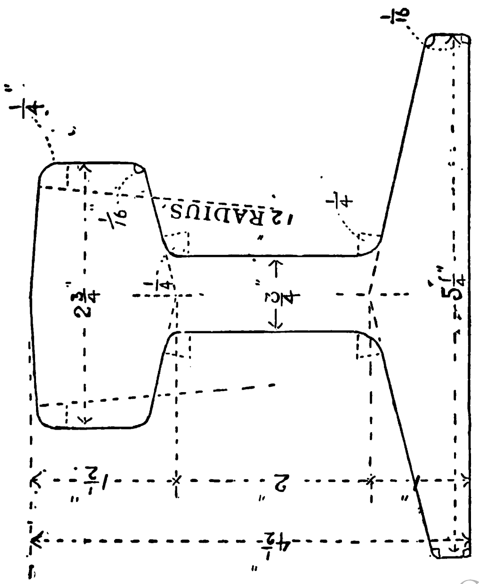
Manufactured only by

THE WEIR FROG CO., CINCINNATI, O.



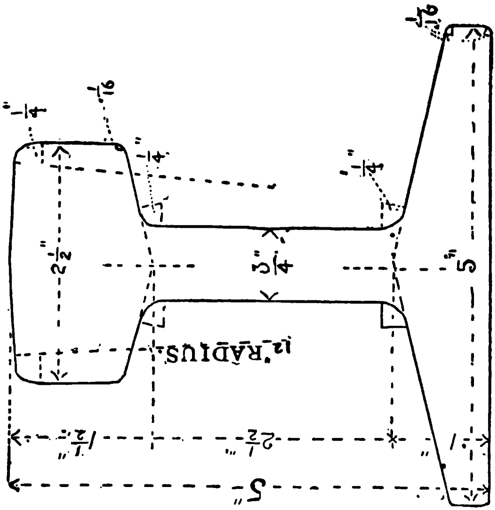
THE WEIR FROG CO., CINCINNATI, O.


PATENTED.
THREE-THROW SPLIT SWITCH, WITH LOW STAND.
THE WEIR FROG CO. CINCINNATI, OHIO.



[Fig. 16.]—Half Size.

Head, 36.6. Web, 15.6.
Flange, 37.8 Weight per Yard, 90 lbs.



[Fig. 17.]—Half Size.

Head, 33.5. Web, 19.4.
Flange, 37.1. Weight per Yard, 90 lbs.

The object sought was to increase the tractive power, a very good feature in a locomotive.

But it was not stated over what kind of rails this locomotive would run. Now it is likely that the locomotive mentioned will, when put in service, wear out double as many rails in a given time, as one where the same amount of weight is distributed over two pair of drive wheels.

Nearly every railroad man who has examined the track where a heavy locomotive has been working for some time will say that he has noticed that the top surface of the rails scales off and flattens, and spreads in some cases. This is all the result of the great weight, which is concentrated over the engine's drive wheels, no other part of the train having the same effect on track.

The drive wheels of a locomotive act like a roller on the rails, and with weight enough resting on them, it should not be a hard matter to flatten out the rail into a thin sheet of iron or steel.

I think it would be a good policy for railroads to select for their tracks a rail of the proper shape, weight and hardness, and then adopt a maximum weight over each pair of wheels in their rolling stock, beyond which no manufacturer should be allowed to go, when building cars or locomotives, instead of the practice now in force of running anything from 5 to 75 tons weight from New York to San Francisco, over

rails made of iron or steel, of all varieties of shapes and weights.

Increasing the capacity of cars and the weight of locomotives, it seems to me should not be carried too far until the weight can be more evenly distributed over the track, or until all the railroads which interchange traffic have prepared their track and bridges to receive such cars and locomotives.

Some one perhaps will say, put more wheels under the rolling stock, but here again the limit is nearly reached, especially in locomotives, for unfortunately most all of the railroads have curves in their track which will not admit of very extended improvement in that direction.

There can be no question that, when a pair of wheels is extra heavily loaded, they have a bad effect on track, whether on a car or locomotive. Because they strike the rail joints and other weak places in track with greater force than any other part of the train, wearing and damaging the track proportionately, and often when the wheel base is made longer to more evenly distribute the load over each pair of wheels, the track is injured and its safety is impaired, through the inability of the locomotive or cars to pass around sharp curves without crowding the rails and wearing them along the gauge lines. Now a days a car or locomotive, should be constructed with the view of travelling over any railroad track in the United States where traffic is interchangeable.

CURVED TRACKS.

CHAPTER V.

1, RADIUS AND DEGREE OF CURVES, Fig. 18 -2, Curve Radius—3, Method of Staking or Laying out a Side Track without the Aid of Transit or Chain, Fig. 19—4, To Lay Out a Four Degree Curve --5, To Lay Out a Curve by the Eye, Fig. 20—6, Radii, Ordinates, Tangent and Chord Deflections, Table III—7, To Find the Radius of a Curve Required to Reach any Desired Object, the Point of Curve being known, Fig. 21—8, Method of Laying a Spur Track Curve, Fig. 22—9, Three Methods of Finding the Difference in Length Between the Inner and Outer Rails of a Curve—10, Broken or Staggered Joints, Tables IV and V.

11, ELEVATION OF CURVES—12, Elevate for the Greatest Speed—13, Sharp Curves and Elevation—14, When Speed of Trains Does not Exceed 15 Miles per Hour—15, The Curve on Passing Tracks, etc.—16, Table of Ordinates, Fig. 23—17, How to Apply it—18, Compound Curves—19, Frequent Changes—20, Curve Track Gauges—21, Laying the Rails on Curves—22, To Curve a Rail Properly—23, The Curve Approach—24, Printed Information for Foremen—25, Guard Rails on Curves—26, Between Reverse Curves—27, Putting the Elevation in Curves.

28, RULES FOR LINING CURVES, Fig. 24—29, Effect of Locomotives and Car Wheels on Track—30, Elevation Balance—31, Liability of Derailment—32, Reduced Speed—33, A Curve in a Sag—34, Care of Curves—35, Lining Curves—36, Straight Rails in Curves—37, Number of Rails Wanted on Curves—38, Foremen Should Know the Degree—39, A Good Curve—40, Dangerous Car Wheels on Curves.

RADIUS AND DEGREE OF CURVES.

1. Figure 18 illustrates a very simple method by which to determine the radius or degree and point of curve. When the curve holds 90 degrees of angle, the radius is the same length as the tangents of the curve. As shown in the example, the letters, G and F, represent the rails of a piece of straight track from which it is desired to turn out a curve track, which, when distant from said track 573 feet and at right angles with it, will parallel a building, marked E, also with straight track.

Measure the distance in a straight line from A to B which is 573 feet, the radius of the curve. This radius being one-tenth of 5,730 feet, the radius of a one degree curve, a ten degree curve is required. Now turn off at right angles at B and measure a distance equal to the radius 573 feet, and this locates the point of curve at C. The letter, D, marks the center of a circle. It is at a point equidistant from A and C. A cord, equal in length to the radius, if attached to a stake at D, will reach both points at A and C, and if swung around between these points it will form a correct curve.

It is not advisable to use a radius when laying out a curve which is much less than the example except when putting in a "Y" track or to save costly filling and when track room is scarce.

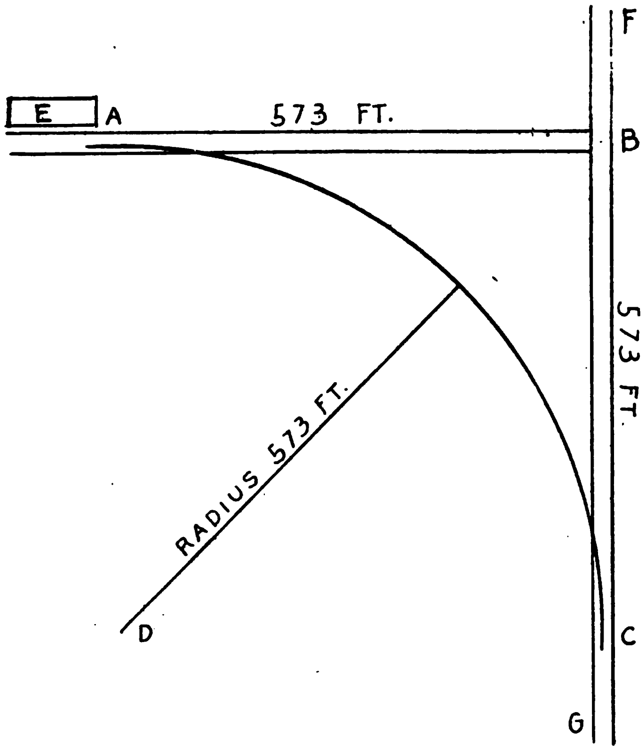


Fig. 18.

After finding the radius point and degree of a curve by the preceding method, a foreman can lay out the curve by the method given in paragraph 5, or he can use a cord sixty-two feet long and lay out the curve by the method given in the rule for lining curves by beginning at the point of curve and deflecting one inch at the middle of the cord for each degree of curvature.

CURVE RADIUS.

2. A radius is half the diameter of a circle, or a line one end of which will reach any part of the ciicumference, if the other end of it is secured at the center of the circle.

TABLE OF RADIUS.

DEGREE OF CURVE.	LENGTH OF RADIUS.	DEGREE OF CURVE.	LENGTH OF RADIUS.
1	5.730 feet	11	521 feet
2	2.865 "	12	477½ "
3	1.910 "	13	440¾ "
4	1. 321½ "	14	409¼ "
5	1.146 "	15	382 "
6	955 "	16	358½ "
7	818½ "	17	337 "
8	716¼ "	18	318⅓ "
9	636⅔ "	19	301½ "
10	573 "	20	286½ "

METHOD OF STAKING OR LAYING OUT A SIDE TRACK WITHOUT THE AID OF TRANSIT OR CHAIN.

3. It is often the case that a side track, to some warehouse or other building close to a railroad, is wanted to be put in on short notice. In

such cases the companies engineers cannot always be on hand to lay out the work. Then the roadmaster or one of his assistants, must get the track laid as best they can. There are many side tracks laid which have the grade and other conditions so favorable that any intelligent track foreman can do the necessary work without any teaching, but it is not always plain sailing and the following simple rules and examples will be found serviceable as a guide to work by. Where there is plenty of track room and the intended side track is to run straight in a diagonal direction from the track which it is thrown off from. First locate a point where the outside rail of the new track will come where it passes the building, then measure the distance in feet from this point to a point on the nearest rail on the old track squarely opposite. Multiply this distance by the number of the frog you are about to use and the product will be the distance in feet that the point of frog must be set ahead of either of the first points where measurements were made in order to have a straight side track from the heel of the frog to where it passes the building.

EXAMPLE:—A and B, Fig. 19, are the ends of a line running across from a permanent track to a point where outside rail of the new track will pass a building. The length of this line one hundred feet, the number of the frog we will suppose to be one to seven; 7x100 equals 700, the distance from A to C. The point of frog should

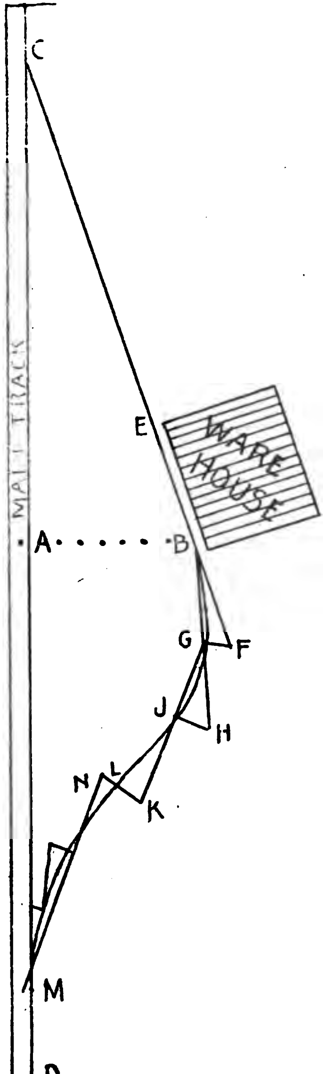


Fig. 19.

come at C for your switch. After passing the building the new track may be run into the permanent track at whatever point is most convenient, such as is shown at D, unless it is desired to maintain a spur track, when it will not be necessary to pass the building any more than enough to have the required track room for cars.

As will be seen in the preceding example, the ends of a track running from B to D, would require a curve in its construction in order to complete the new track so that it could be used from either end, C or D.

TO LAY OUT A FOUR DEGREE CURVE.

4. The method of procedure when laying out curve track is more difficult than a straight track but simple enough when once understood. A knowledge of the deflection distances of curves is essential and is given in table III. Let E B represent the center line of a straight track running parallel with the building shown in figure 19, set a stake at E, and one at B, then set a third stake at F, one hundred feet ahead of B, making E, B and F all in a straight line. The tangent deflection distance for a 4 degree curve is $3\frac{1}{2}$ feet or the distance as shown from F to G, set a stake at G, square with the stake at F. G is then the first center stake in a four degree curve, now measure one hundred feet from G and set another stake at H in a line with B and

G. again measure in the chord deflection distance, 7 feet, to J which is the next center stake of the curve, measure another one hundred feet to K in a straight line with J and G, and the chord deflection distance to L which is the third centre stake of the curve. We have now covered one half the distance between B and M. To continue the track from L to M, it is necessary to reverse the curve, to do which we lay off a curve from M to N in the same manner as explained in paragraphs 5 and 8.

TO LAY OUT A CURVE BY THE EYE.

5. In Fig. 20, the chord, H C, subtends the angle formed by the tangent, A B, produced to H, with the chord, B C, is called the *tangent deflection.* The chord, I D, which subtends the angle formed by the chord, B C, produced to I, with the chord, C D, is called the *chord deflection.* The number of degrees in the angle, I C D, expresses the degree of curve. The tangent deflection is equal to one-half the chord deflection.

Table 111, has the radius, tangent deflection, chord deflection and middle ordinates, calculated for chords of 100 ft., for differences of 10 minutes. For a curve containing odd minutes, the parts can be readily calculated by simple proportion. Having these respective distances, any intelligent foreman can trace a curve on the ground, with tolerable accuracy, especially where

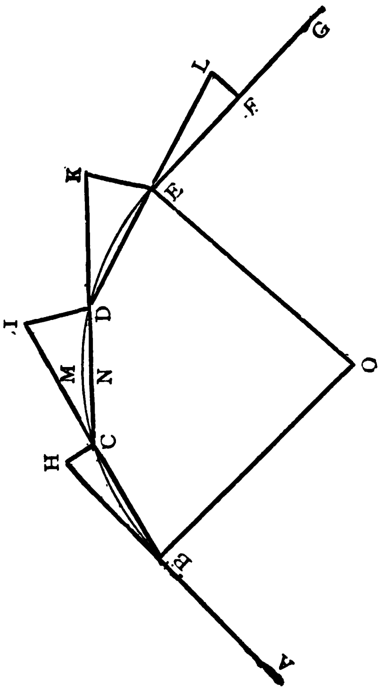


Fig. 20.

the ground is favorable. Suppose it be required to lay out in this manner, a four degree curve.

First find from table 111, the tangent deflection, H C, corresponding to a four degree curve, viz. 3 ft. $5\frac{7}{8}$ in's. and also the chord deflection, I D, or K E, 6 ft. $11\frac{3}{4}$ in's. Then from the starting point B, and in line with A B, measure B H, equal to 100 ft., and mark the point H. Swing the tape around toward B C, keeping the end at B fixed, at the same time measure from the point H, the tangent deflection 3 ft. $5\frac{7}{8}$ in's., and place a stake at C, for the first point on the curve. Then make C I, equal 100 ft., putting in a peg at I, in line with those at B and C. Swing the tape or cord around until I D is equal to the chord deflection, 6ft. $11\frac{3}{4}$ in's. Place a stake at D for the second point on the curve.

In the same manner continue the chord deflections until the end of the curve is reached at E.

In order to pass from the curve at E, into the next tangent, E G, make E L equal to 100 ft., and put in a peg at L in line with those at D and E. Swing the tape around until F L is equal to the tangent deflection. Then will a line, passing through E and F, be tangent to the curve at E.

If the last chord, D E, is less than 100 ft., its tangent deflection can be calculated by multiplying the square of the sub-chord by the tangent deflection of a 100 ft. chord, and dividing by 1000. Then throw off a tangent to the curve at

D, lay off from it the calculated tangent deflection for the sub-chord, making D E of the given length. Lay the curve out and let the stakes form the center line of track.

RADII, ORDINATES, TANGENT AND CHORD DEFLECTIONS.

6. Curves are spoken of as being of a certain *degree* or *radius*. The radii of curves are proportional to the degree of curvature. The radii corresponding to any degree may be found *approximately*, by dividing 5730 (the radius of a 1 degree curve) by the degree of curve.

Radius of a 5 degree curve $= 5730 \div 5 =$ 1146.

This rule is very close for radii of not less than 500 ft.

The middle ordinate of a chord is the perpendicular distance from the middle of the chord to the curve; thus M N, Fig. 20, is the middle ordinate of the chord, C D.

The middle ordinate may be found, *approximately*, by dividing the square of the chord by eight times the radius. The error for a 50 ft. chord on a 20 degree curve is only 1-32 of an inch.

The chord deflection of a 100 ft. chord may be ascertained (exactly) by dividing 10,000 by the radius in feet. The tangent deflection is one-half the chord deflection.

TABLE III.—Radii. Also Ordinates and Deflections for 100 Feet Chords.

Degrees. D.	Degrees. M.	Radius. FT.	Middle Ordinate. FT.	Middle Ordinate. IN.	Tangent Deflection. FT.	Tangent Deflection. IN.	Chord Deflection. FT.	Chord Deflection. IN.
0	10	34377	0	0 7/16	0	1 3/4	0	3 1/2
	20	17189	0	0 7/8	0	3 1/2	0	7
	30	11459	0	1 5/16	0	5 1/4	0	10 1/2
	40	8594	0	1 3/4	0	7	1	2
	50	6875	0	2 3/16	0	8 3/4	1	5 7/16
1		5730	0	2 5/8	0	10 1/2	1	8 13/16
	10	4911	0	3 1/16	1	0 3/16	2	0 7/16
	20	4297	0	3 1/2	1	2	2	3 13/16
	30	3820	0	3 15/16	1	3 11/16	2	7 7/16
	40	3438	0	4 3/8	1	5 7/16	2	10 7/8
	50	3125	0	4 13/16	1	7 3/16	3	2 3/8
2		2865	0	5 1/4	1	8 15/16	3	5 7/8
	10	2645	0	5 11/16	1	10 11/16	3	9 3/8
	20	2456	0	6 1/8	2	0 7/16	4	0 7/8
	30	2292	0	6 9/16	2	2 3/16	4	4 3/8
	40	2149	0	7	2	3 15/16	4	7 7/8
	50	2022	0	7 7/16	2	5 11/16	4	11 5/16
3		1910	0	7 7/8	2	7 7/16	5	2 13/16
	10	1810	0	8 5/16	2	9 3/16	5	6 5/16
	20	1719	0	8 3/4	2	10 7/8	5	9 13/16
	30	1637	0	9 3/16	3	0 11/16	6	1 5/16
	40	1563	0	9 5/8	3	2 3/8	6	4 3/4
	50	1495	0	10 1/16	3	4 1/8	6	8 1/4
4		1433	0	10 1/2	3	5 7/8	6	11 3/4
	10	1375	0	10 7/8	3	7 5/8	7	3 1/4
	20	1322	0	11 5/16	3	9 3/8	7	6 3/4
	30	1274	0	11 13/16	3	11 1/8	7	10 1/4
	40	1228	1	0 3/16	4	0 7/8	8	1 3/4
	50	1186	1	0 11/16	4	2 5/8	8	5 3/16
5		1146	1	1 1/8	4	4 3/8	8	8 11/16
	10	1109	1	1 1/2	4	6 1/16	9	0 3/16
	20	1075	1	2	4	7 13/16	9	3 11/16
	30	1042	1	2 3/8	4	9 9/16	9	7 1/8
	40	1012	1	2 7/8	4	11 5/16	9	10 5/8
	50	988	1	3 1/4	5	1 1/16	10	2 3/16
6		955	1	3 11/16	5	2 13/16	10	5 5/8
	10	930	1	4 1/8	5	4 9/16	10	9 1/8
	20	905	1	4 9/16	5	6 5/16	11	0 9/16
	30	882	1	5	5	8	11	4
	40	860	1	5 7/16	5	9 3/4	11	7 1/2
	50	839	1	5 7/8	5	11 1/2	11	11
7		819	1	6 5/16	6	1 1/4	12	2 1/2
	10	800	1	6 3/4	6	3	12	6
	20	782	1	7 3/16	6	4 3/4	12	9 1/2
	30	765	1	7 5/8	6	6 1/2	13	1
	40	748	1	8 1/16	6	8 1/4	13	4 7/16
	50	732	1	8 1/2	6	10	13	8
8		717	1	8 15/16	6	11 3/4	13	11 7/16
	10	702	1	9 3/8	7	1 7/16	14	2 7/8
	20	688	1	9 13/16	7	3 3/16	14	6 3/8
	30	675	1	10 1/4	7	4 15/16	14	9 7/8
	40	662	1	10 11/16	7	6 11/16	15	1 3/8
	50	649	1	11 1/8	7	8 7/16	15	4 15/16
9		637	1	11 9/16	7	10 1/8	15	8 5/16
	10	626	2	0	7	11 7/8	15	11 13/16
	20	615	2	0 7/16	8	1 5/8	16	3 1/4
	30	604	2	0 7/8	8	3 3/8	16	6 3/4
	40	593	2	1 5/16	8	5 1/8	16	10 1/4
	50	583	2	1 3/4	8	6 7/8	17	1 11/16
10		574	2	2 3/16	8	8 5/8	17	5 3/16
	30	546	2	3 1/2	9	1 13/16	18	3 5/8
11		522	2	4 13/16	9	7	19	2
	30	499	2	6 1/8	10	0 1/4	20	0 1/2
12		478	2	7 7/16	10	5 7/16	20	10 7/8
	30	459	2	8 3/4	10	10 5/8	21	9 1/4
13		442	2	10 1/16	11	3 7/8	22	7 11/16
	30	425	2	11 3/8	11	9 1/16	23	6 1/8
14		410	3	0 11/16	12	2 1/4	24	4 1/2
	30	369	3	2	12	7 7/16	25	2 3/4
15		383	3	3 5/16	13	0 5/8	26	1 1/4
	30	371	3	4 5/8	13	5 13/16	26	11 5/8
16		359	3	5 15/16	13	11	27	10
	30	348	3	7 1/4	14	4 3/16	28	8 3/8
17		338	3	8 5/8	14	9 3/8	29	6 3/4
18		320	3	11 1/4	15	7 3/4	31	3 7/16
19		303	4	1 7/8	16	6 1/16	33	0 1/8
20		288	4	4 1/2	17	4 3/8	34	8 3/4
21		274	4	7 1/8	18	2 11/16	36	5 3/8
22		262	4	9 3/4	19	1	38	2
23		251	5	0 7/16	19	11 1/4	39	10 1/2
24		240	5	3 1/16	20	9 1/2	41	7
25		231	5	5 3/4	21	7 3/4	43	3 1/2

TO FIND THE RADIUS OF A CURVE REQUIRED TO REACH ANY DESIRED OBJECT THE POINT OF CURVE BEING KNOWN.

7. In Fig. 21, A B. represents a tangent, and starting at a point as A, it is required to reach the point C. From the starting point A, measure along the tangent to a point B, square across from C, then measure the perpendicular distance, B C. Then divide the square of the distance, A B, by twice B C, and to the quotient add ½ B C, the result will be the required radius. The line of the perpendicular can be obtained by placing the gauge on the track, and sighting along it; or if A B is only a line of stakes, as the line of the frog produced, lay off on the ground the sides of a right angled triangle, 15, 20 and 25 feet are convenient lengths, always making 15 or 20, coincide with the given tangent. If the main line is curved, the measurements may be taken on the prolongation of the tangent through the starting point.

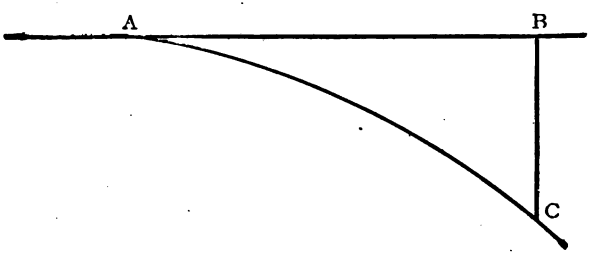


Fig. 21.

EXAMPLE:—Given A B =400 and B C, =162,4, to find radius. Radius = 400×400÷2×162.4+162.4÷2 = 492.6+ 812 = 573.8, the radius of a 10 deg. curve.

If B C and the radius of the curve are given, A B is calculated as follows: From twice the radius subtract B C multiply this difference by B C, and extract the square root.

EXAMPLE:—B C = 162.4 and the radius 573.8. A B = 573.8×2 =1147.6, 1147.6—162.4×162.4 =15996.48, the square root of which is 400—.

METHOD OF LAYING A SPUR TRACK CURVE.

8. In Fig. 22, it is required to lay a permanent track to a warehouse at K, from main line, A D.

Range a tanget, E I, at the proper distance from, and pararallel to the warehouse. Then at a convenient point, as C, on the center line of main track, lay off the angle, D C E, equal to the angle of the frog used. A simple way of doing this is to measure a convenient distance, C D, say 100 ft., along center line of main track, placing a peg at D. Divide this distance by the frog number, and make the perpendicular, D L, equal to the quotient obtained. Produce the line from C through L until it intersects the tangent from the warehouse in E, mark this point. Take from turnout table No. 1, in column headed, "Tangent," the distance opposite the number of frog used. Make C B equal to this distance, and B will be the heel of switch. Also make

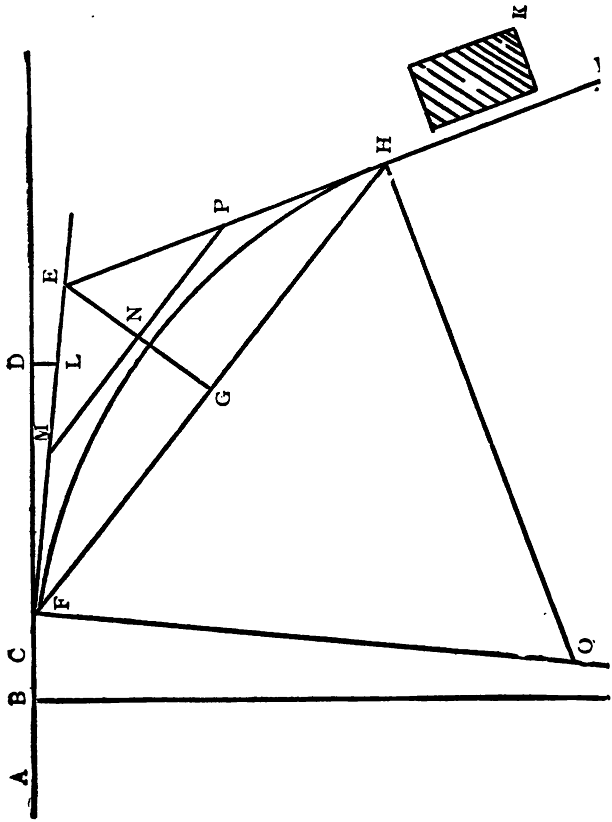


Fig. 22.

C F, the same distance, and F will be a point on center line of turnout, opposite the point of frog.

It now remains to join the straight lines, C E, and I E, with a curve. If it is desired to commence the curve at the point of frog, measure the distance, F E, and lay off an equal distance, E H, on the tangent E I. F and H will be, respectively, the beginning and end of curve. To find the radius to join these tangents, measure the distance F H, putting a peg at G, midway and on line between F and H. Measure E G. The radius required will be equal to F G multiplied by F E, and the product divided by E G. The curves can then be put inby the method given in paragraph 5, describing how to lay out a curve by the eye.

EXAMPLE:—F E measures 260, F G, 254 and E G, 57.61. Radius $= 260 \times 254 \div 57.61 =$ 1146.5, Corresponding to a 5 deg. curve

If a radius is assumed, the distances to measure down the tangents to set the beginning and end of curve must be calculated. From E, measure any convenient equal distances, E M and E P. Measure M P, putting a point N midway and on line between them, and measure E N. The tangents of the curve will be equal to E N multiplied by the radius and the product divided by M N.

EXAMPLE:—M N $= 80$, radius 955, E N, $= 18$. Tangents $= 855 \times 18 \div 80 = 201.5$.

THREE METHODS OF FINDING THE DIFFERENCE IN LENGTH BETWEEN THE INNER AND OUTER RAILS OF A CURVE.

9. 1st. The difference in length may be taken at 1 and 1-32 inches, per degree of curve, per 100 ft.

EXAMPLE:—To find the length between the inner and outer rails on 600 ft. of 10 deg. curve. Here 10×1 1-32×6 = 5.124 ft. = 5 ft. 1½ in's. Decimal parts of a foot are reduced to inches in table V.

2nd. Divide the distance from center to center of the rails (ordinarily 4 ft. 11 inches equal 4.9167 ft.) by the radius of the curve, and multiply the result by the length of the curve in ft.

EXAMPLE:—Taking the same example 600 ft. of ten deg. curve, 4.9167÷573.7×600 = 5.142 ft. = 5 ft. 1¾ in's.

3rd. Multiply the excess for a whole circumference, by the total number of degrees in the curve, * and divide the product by 360. The excess for a whole circumference no matter what the degree of curve, is equal to twice the distance between rail centers multiplied by 3.1416.

Where the distances between rail centers is 4 ft. 11¾ in's. the excess for a whole circle is 30.892 ft.

EXAMPLE:—Taking the same example 600 ft. of 10 deg. curve. 30.892 × 600÷360= 5.148 ft. = 5 ft. 1¾ in's.—

For the easier curves that are laid to exact gauge the first method is the simplest. On sharper curves, where the gauge is widened, use the second method, or prepare a table by the third method.

"BROKEN" OR "STAGGERED" JOINTS ON CURVES.

10. Whenever it is required to lay "broken" joints on curves, and even joints on tangent, it is necessary to cut but one rail. Find the difference in length between the inner and outer rails of the curve. Cut the rail so that one piece will be as much longer than the other piece, as the difference between the inner and outer rails of the curve. Lay the longer piece on the outside at the beginning of curve. Continue the joints thus broken until the other end of the curve is reached, where it wlil be necessary to lay the other piece of the rail that was cut to make the joints even again.

When it is desired to continue "broken" joints through two or more curves with short tangents between them, it may be done by adding together the central angles of the curves turning to right, subtracting therefrom, all angles of curves to left, and treating the difference thus obtained as one central angle of curvature.

TABLE IV.—Middle Ordinates for Curving Rails.

Deg. of Cr.	LENGTH OF RAILS.					
	30 ft	28 ft	26 ft	24 ft	22 ft	20 ft
	INS.	INS.	INS.	INS.	INS.	INS.
1	0 1/4	0 3/16	0 3/16	0 3/16	0 1/8	0 1/8
2	0 1/2	0 7/16	0 3/8	0 5/16	0 1/4	0 3/16
3	0 11/16	0 5/8	0 9/16	0 7/16	0 3/8	0 5/16
4	0 15/16	0 13/16	0 11/16	0 5/8	0 1/2	0 7/16
5	1 3/16	1 1/16	0 7/8	0 3/4	0 5/8	0 9/16
6	1 7/16	1 1/4	1 1/16	0 7/8	0 3/4	0 5/8
7	1 5/8	1 7/16	1 1/4	1 1/16	0 7/8	0 3/4
8	1 7/8	1 5/8	1 7/16	1 3/16	1	0 7/8
9	2 1/8	1 7/8	1 5/8	1 3/8	1 1/8	0 15/16
10	2 3/8	2 1/16	1 3/4	1 1/2	1 1/4	1 1/16
11	2 5/8	2 1/4	1 15/16	1 11/16	1 3/8	1 1/8
12	2 13/16	2 1/2	2 1/8	1 13/16	1 9/16	1 1/4
13	3 1/16	2 11/16	2 5/16	1 15/16	1 5/8	1 3/8
14	3 5/16	2 7/8	2 1/2	2 1/8	1 3/4	1 1/2
15	3 9/16	3 1/16	2 11/16	2 1/4	1 15/16	1 9/16
16	3 3/4	3 1/4	2 13/16	2 3/8	2 1/16	1 11/16
17	4	3 1/2	3	2 7/16	2 3/16	1 3/4
18	4 3/16	3 11/16	3 3/16	2 11/16	2 5/16	1 7/8
19	4 7/16	3 7/8	3 3/8	2 [illegible]	2 7/16	2
20	4 11/16	4 1/8	3 9/16	3	2 9/16	2 1/8

ELEVATION OF CURVES.

Degree of Curve.	Length of Approach.	Elevation.	Width of Gauge.	Speed of trains.
1............	60 feet.....	1 inch	4 ft. 8½ inches..	60 m. pr. h.
2............	120 "	2 inches....	4 " 8½ " ..	60 "
3............	150 "	2½ "	4 " 8¾ " ..	60 "
4.....	180 "	2¾ "	4 " 8¾ " ..	55 "
5............	180 "	3 "	4 " 8¾ " ..	50 "
6............	210 "	3¼ "	4 " 8¾ " ..	45 "
7............	210 "	3½ "	4 " 9 " ..	40 "
8............	240 "	3¾ "	4 " 9 " ..	35 "
9............	240 "	4 " ...	4 " 9 " ..	30 "
10............	270 "	4¼ "	4 " 9 " ..	25 "
11............	270 "	4½ "	4 " 9¼ " ..	20 "
12............	270 "	4¾ "	4 " 9¼ " ..	15 "
13............	240 "	4½ "	4 " 9¼ " ..	10 "
14............	240 "	4¼ "	4 " 9¼ " ..	10 "
15............	240 "	4 "	4 " 9½ " ..	10 "
16...	240 "	4 "	4 " 9½ " ..	10 "

11. The above table for elevation of curves is practical, and has given satisfaction when tried

on a single track railroad. It is based on the following theories:

All curves, when it is possible, should have an elevated approach on the straight main track, long enough for trains to have ample time to go on and off the curve without any shock such as there would be where the elevation was on the curve only.

The approach should be elevated in proportion to the elevation on the curve, not the degree of curve, and carried out at each end of the curve 30 feet, or one rail length, for each half inch, or fraction thereof, of the maximum elevation on the curve. The rail joint is the best place for trackmen to adjust the elevation when raising track. It requires a greater amount of elevation on the first three or four degrees of curvature to balance the cars properly, and change the center of gravity more towards the inside rail in order to allow the wheels to vibrate and adjust their circumference to prevent slipping. After this is accomplished, the same conditions may be maintained by only increasing the elevation per degree at the rate of one-fourth of an inch, as long as the curve is not too sharp to run trains at a good speed. But when a curve is so sharp that the speed of trains going over it must be reduced materially, the elevation may also be reduced.

The gauge of curve track is widened for the reason that if the standard gauge is maintained

TABLE V.—Inches Reduced to Decimals of a Foot.

INS.	FT.	INS.	FT.	INS.	FT	INS.	FT.	INS.	FT.	INS.	FT.	INS.	FT.	INS.	FT.	INS.	FT.	INS.	FT.	INS.	FT.	INS.	FT.
0	.0000	1	.0833	2	.1667	3	.2500	4	.3333	5	.4167	6	.5000	7	.5833	8	.6667	9	.7500	10	.8333	11	.9167
1/16	.0052		.0885		.1719		.2552		.3385		.4219		.5052		.5885		.6719		.7552		.8385		.9219
1/8	.0104	1/8	.0938	1/8	.1771	1/8	.2604	1/8	.3438	1/8	.4271	1/8	.5104	1/8	.5938	1/8	.6771	1/8	.7604	1/8	.8438	1/8	.9271
3/16	.0156		.0990		.1823		.2656		.3490		.4323		.5156		.5990		.6823		.7656		.8490		.9323
1/4	.0208	1/4	.1042	1/4	.1875	1/4	.2708	1/4	.3542	1/4	.4375	1/4	.5208	1/4	.6042	1/4	.6875	1/4	.7708	1/4	.8542	1/4	.9375
5/16	.0260		.1094		.1927		.2760		.3594		.4427		.5260		.6094		.6927		.7760		.8594		.9427
3/8	.0313	3/8	.1146	3/8	.1979	3/8	.2813	3/8	.3646	3/8	.4479	3/8	.5313	3/8	.6146	3/8	.6979	3/8	.7813	3/8	.8646	3/8	.9479
7/16	.0365		.1198		.2031		.2865		.3698		.4531		.5365		.6198		.7031		.7865		.8698		.9531
1/2	.0417	1/2	.1250	1/2	.2083	1/2	.2917	1/2	.3750	1/2	.4583	1/2	.5417	1/2	.6250	1/2	.7083	1/2	.7917	1/2	.8750	1/2	.9583
9/16	.0469		.1302		.2135		.2969		.3802		.4635		.5469		.6302		.7135		.7969		.8802		.9635
5/8	.0521	5/8	.1354	5/8	.2188	5/8	.3021	5/8	.3854	5/8	.4688	5/8	.5521	5/8	.6354	5/8	.7188	5/8	.8021	5/8	.8854	5/8	.9688
11/16	.0573		.1406		.2240		.3073		.3906		.4740		.5573		.6406		.7240		.8073		.8906		.9740
3/4	.0625	3/4	.1458	1/4	.2292	3/4	.3125	3/4	.3958	3/4	.4792	3/4	.5625	3/4	.6458	3/4	.7292	3/4	.8125	3/4	.8958	3/4	.8792
13/16	.0677		.1510		.2344		.3177		.4010		.4844		.5677		.6510		.7344		.8177		.9010		.9844
7/8	.0729	7/8	.1563	7/8	.2396	7/8	.3229	7/8	.4063	7/8	.4896	7/8	.5729	7/8	.6563	7/8	.6396	7/8	.8229	7/8	.9063	7/8	.9896
15/16	.0781		.1615		.2448		.3281		.4115		.4948		.5781		.6615		.7448		.8281		.9115		.9948

while the curvature increases, as soon as the difference between wheel flange gauge and track gauge is taken up, by the length of wheel base, the wheels can no longer turn freely and must therefore slip, wearing and crowding the rails, increasing the liability to climb the rails, and making it more difficult for a locomotive to pull the cars. The curves on a standard gauge road need to be widened in the gauge, if for no other reason, than that the cars of other roads which have a wider gauge are hauled over them. The gauge of curves should be widened about 1-16th of an inch per degree, and not to exceed one inch on any curve. But in order not to multiply the number of gauges or complicate their adjustment, the width of gauge, as given in rule, is increased one-fourth of an inch for four degrees at once. The speed of trains as shown in rule is a high limit, and should not be exceeded, because no matter how good a curve track is, the defects in rolling stock, the length of cars and wheel base, the manner of coupling cars, the fact that inside and outside wheels are unable to turn independently of each other, and many other causes, all tend towards liability to accident, as the limit in degree of curvature is approached.

On railroads where the speed of trains is not limited the elevation may be increased at the rate of three quarters of an inch per degree of curvature, as high as six degrees, but this should be the maximum elevation except when the

curve is in a sag.

This elevation of three-fourths of an inch per degree is best adapted to a double track railroad, or one where passenger trains run exclusively on one track.

ELEVATE FOR THE GREATEST SPEED.

12. I am decidedly of the opinion that all curves in track should be elevated on outside rail to suit the highest speed of trains passing over that part of the track. To assume that the speed of freight trains is regulated by time cards or rules is nonsense. It is a notorious fact that freight trains instead of running slower than pas-enger trains, do run faster than the average schedule time of some passenger trains, especi-ally when descending grades, trying to make up time or meeting points when the train is light, or, as is often the case, when they receive positive orders to run at an increased rate of speed.

The chief aim of conductors is to make time, and many of them will steal time at a station where they are delayed if the engineer is willing and there is a possibility of their getting to the next station on time by running faster than the regular speed of freight trains; I have noticed that the speed of all trains on a single track will average running between stations much nearer the time of passenger trains than a lower rate of speed, as given by some authorities.

For these and similar reasons I do not think it possible to make any average rate for speed of trains of all classes on a single track, nor to make a rule for the elevation of curves which would be anything like accurate, except on a four track railroad where trains always run in one direction. Then the speed would of course be more regular. If a curve requires a certain elevation in order to carry a train safely over it at a speed of 45 or 50 miles per hour, it does not seem to me to be a reasonable theory to split the difference and reduce the elevation because another train or a majority of the trains will run over the same track at a slower rate of speed. Reducing the elevation on curves to suit the speed of the slower running trains, is equivalent to admitting that the same elevation is enough for faster trains on the same track, which is not the case, except when the greater elevation was excessive. Regulate speed to suit the curve or elevate the curve for the greatest speed.

SHARP CURVES AND ELEVATION.

13. It seems remarkable to me that of all the different authorities on the elevation of curves few have seen fit to say at what degree of curvature elevation should stop, or when it would be too great for the width of the track. Various persons have advocated elevating the outer rail on curves one-half inch, three-fourths of an inch,

and as high as one inch and a quarter per degree of curvature, while some civil engineers have gone so far as to make tables giving the elevation of curves from 1 up to 20 degrees for different rates of speed of trains, carrying the elevation into feet instead of inches. All of this must seem ridiculous to any practical trackman, who knows it is not safe to run trains at such high rates of speed on very sharp curves, nor to turn a piece of curve track upside down in order to get a train around it. It seems as if some writers were too superficial in the treatment of the subject, while others in their effort to impart knowledge have over-reached themselves. And I believe these are the causes of the conflict and diversity of opinion amongst railroad men of the present day in regard to proper elevation of curves. Now I maintain that the greatest elevation of the outer rail on curves, no matter how sharp they are, should not exceed one inch to the foot width of track, because, when the maximum elevation is reached of about 5 inches, even at this elevation the curve is too sharp for the main track of any railroad where it is desirable to make fast time. If sharper curves are necessary in a yard or at other places, the elevation should be lessened instead of increased, because trains must necessarily run slow at such places. Instead of trying to tinker up the elevation on very sharp curves on the main track, so that trains could run around them, the company

should at once take such curves out of their track, or at least reduce the curvature to a minimum.

There is a good deal of valuable time wasted by trains running slow on sharp curves, and liability to accident is much greater than on straight track.

There is also an immense amount of wear and tear on the rolling stock and track, especially the wheels and rails, and the amount of money lost is so great on account of the limited number of freight cars which may be hauled that the saving which could be effected in a short time on some railroads with a heavy traffic would pay all the expense of taking such curves out of the track when it is possible to dispense with them. The necessity for economy in the construction of a new road is in most instances the only excuse for having sharp curves in the track. When it is possible, railroad companies should take out of their main track, as fast as they can afford the means for carrying on the work, every curve which will not admit of running trains at a speed of 60 miles per hour or which will materially affect the number of cars a locomotive can haul.

The opinion seems to be general amongst the leading track men and engineers of the present day, that the easement of sharp curves by compounding them on the approach, so as to have the least amount of curvature next the tangent, and gradually increase the degree up to the middle of the curve where it should be greatest is the best method of securing a good riding track for trains which run at high rates of speed.

When laying out Reverse Curves of one two or three degrees, there should be left between them not less than 60 feet of a level tangent, and this distance should be increased in proportion to the degree of curvature, either side of the tangent to enable track men to put in a gradual approach to each curve when elevating the outer rail.

Curves should not be put in on any railroad except where the natural conditions are such, that their use cannot be avoided. Or where the economy in cost of construction is so great that their benefits as against disadvantages, can be clearly demontrated.

WHEN SPEED DOES NOT EXCEED FIFTEEN MILES PER HOUR.

14. On any curve where the speed of trains does not exceed fifteen miles per hour an elevation of the outside rail equal to the middle ordinate of a thirty foot rail on the same curve will be sufficient.

RULE.—For every degree of curve give the outside rail one-fourth of an inch elevation, widening the gauge of track for each degree as in rule for elevating the outside rail of curves.

THE CURVE ON PASSING TRACK, ETC.

15. On curves where the speed is less than ten miles per hour, such as those beyond the switch leads on yard or "Y" tracks, elevate the outside rails as follows:

RULE:—Commence at one degree, giving

$\frac{1}{4}$ inch elevation, and for every degree of curve thereafter increase the elevation at the rate of 3-16 of an inch to the degree of curve, widening the gauge as in rule for elevation. There should never be any elevation in the lead rails of switches between the heel of frog and end of switch.

TABLE OF ORDINATES.

16. The following table showing how to find the degree of a curve by the middle ordinate, with strings or cords of different lengths, will be of great value to section foremen who have heretofore had no instruction on this subject. The reason why so many different lengths of cord are given with the ordinate is that the foreman who desires to be accurate with his work may use any of them as circumstances may require.

Length of Chord Feet.	Middle Ordinate of a one Degree Curve.
20 feet	$\frac{1}{8}$ Inch
30 feet	$\frac{1}{4}$ Inch
44 feet	$\frac{1}{2}$ Inch
50 feet	$\frac{5}{8}$ Inch
62 feet	1 Inch
100 feet	$2\frac{5}{8}$ Inches
120 feet	$3\frac{3}{4}$ Inches

EXAMPLE.

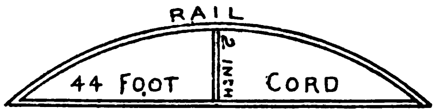


Fig. 23.—Four Degree Curve.

The above illustration Fig. 23, will show how to apply any of the different lengths of string in the table of ordinates and to ascertain the degree of curve.

HOW TO APPLY IT.

17. Draw a cord tight on the inside of the gauge line of the rails on a curve, measure from the center of the cord to the rail. The distance in inches divided by the middle ordinate for that length of cord as shown in the table will give you the degree of the curve.

COMPOUND CURVES.

18. When the greater degree of a compound curve begins at about the middle of the curve, elevate the outside rail gradually from the approach of curve, giving the elevation which belongs to the greater degree, when you reach it.

In the same manner lessen the elevation as you approach the straight track at the opposite end of the curve.

If the greater degree is met at the point of curve, and the curve terminates with a less degree elevate the outside rail for the greater degree until you come to where it meets the less degree; then diminish the elevation one-half inch to the rail length until you reach the elevation which properly belongs to the less degree of curve, then continue this elevation to the opposite end or the approach of the curve.

FREQUENT CHANGES.

19. Where the changes are frequent and abrupt in a compound curve, it is generally best to elevate the outer rail for the highest degree and carry this elevation uniformly throughout the curve. Never change the elevation more than *one-half inch* in a rail length in passing from one degree of curve to another, otherwise a swing or a jar will be felt in passing over that place on a train.

CURVE TRACK GAUGES.

20. Section foremen should be provided with a special gauge for gauging curves, and made in such a manner that when adjusted properly for

work the width of gauge could not be accidenally changed. Track should be spiked accurately.

LAYING THE RAILS ON CURVES.

21. No rails should ever be laid in track and spiked on any curve of over two degrees without first being curved the proper shape. The middle ordinate of a 30 foot rail is one-fourth of an inch on a one degree curve with very little variation up to 10 degrees and is so nearly proportionate to the degree of curve, that it can be used as a guide in curving rails.

TO CURVE A RAIL PROPERLY.

22. Bend or curve the rail through its entire length until the middle ordinate of the rail equals as many quarter inches as there are degrees in the curve for which you are preparing it. To ascertain this, stretch a string between the extreme points of the rail on the gauge side and measure the distance from the center of the string to the gauge side of the rail at its center. For foremen who have not had much practice in curving rails it is best to also measure the distance from the string to the rail at the quarters, seven and on-half feet from the end of a 30 foot rail, and this distance should be three quarters of what it is at the center of the rail. By measure-

ments taken at the quarters it is generally easy to detect a kink in the rail, which should always be taken out. Rails which have a true curve will be in their place in the track ready for spiking and gauging without being held or drawn to place with the bar and will not need rail braces except on very sharp curves laid with soft wood ties. The more accurate the curve of rails, the less lining of track will be needed afterwards.

THE CURVE APPROACH.

23. Where the elevation here given is not divisible evenly into half inches, elevate for the additional fourth of an inch at the point of curve, just as if it were a half-inch.

To illustrate: take a three degree curve, elevation two and one-half inches, length of approach on straight line 150 feet or five rail lengths from point of curve. Elevate the first rail on the straight line one-half inch, the second one inch, the third one and one-half inches, the the fourth two inches, and the fifth joint, or point of curve, two and one-half inches, the full elevation. This elevation should then be carried uniformly to the other end of the curve where it should be eased off on the straight line in the same manner as the approach.

PRINTED INFORMATION FOR FOREMEN.

24. On all curves of over three degrees it would be a good policy to have a plainly painted sign showing the degree of the curve and the speed at which trains should run when passing there. For the sake of economy, the information could be given on a board set in a telegraph pole near the curve. There could also be a rule on the time card calling the attention of the employes most interested to the subject. There is no good reason why a foreman placed in charge of a piece of track should not receive all the information relative thereto that it is possible for the railroad company to give him, instead of having to find it out for himself as best he can. *Printed information from the engineering department should suppliment the track foreman's other instructions and in most cases it would materially assist in bettering the condition of the road, and bring more uniformity into the work.* If every section foreman was provided with a little book giving location, degree and amount of elevation of the outer rail on the curves on his section, together with location, size and number of all culverts and bridges, and distance from stations, also amount of snow fence on cuts, and kind and quantity of rails laid etc. It would be placing the information where it would be of the most practical value to the railroad company.

GUARD RAILS ON CURVES.

25. When speed of trains exceed twenty miles per hour, curves of ten degrees or over should have a guard rail inside the inner rail of curve. This guard rail should be spiked down on the ties all the way around the curve and turn off from the track rail at each end of the curve. The space for the wheel flanges between the guard rail and track rail should be two inches wide. The extra width over standard gauge as given in the table for elevation of curves should be added where the degree of curve makes it necessary to widen the gauge of track.

BETWEEN REVERSE CURVES.

26. Where straight track between two reverse curves is not long enough to give the outside rail the required elevation before reaching the point of either curve, begin to elevate the outside rail at a point mid-way between the curves, and give the first rail one-half inch elevation, after which you can increase the elevation one-half inch to the rail length, or one inch if necessary for sharp curves. When there is a difference of one or more degrees in two reverse curves the greater degree should have the longer approach. Reverse curves should be well surfaced, and the track made as perfect as possible,

and between the approaches of the reverse curves there ought to be at least 60 feet of level track, where the distance between curves will allow it.

PUTTING THE ELEVATION IN CURVES.

27. If the surface level of the whole track throughout a curve is good, and without any sags, you can give the curve the proper elevation with one-half the labor by only picking up the low spots along on the inside rail of the curve and raising the outside rail of the curve out of a face to give it the required elevation. When only the outside rail of a curve is raised up, always be particular to get the ballast under all of the ties which are raised out of their old bed. When dressing curve track between the rails keep the highest point of the material a little closer to the outside rail of the curve about one fourth of the gauge of the track. This allows most of the water which falls on the track to run off under the inside rail of the curve. If the highest point of the material used to dress the center of the track is left midway between the rails as on straight track any water which falls upon the track cannot readily run off under the outside rail of a curve which has three or four inches of elevation, and in many places the track will be seriously injured by water settling down under the outside rail and between the track ties. When-

ever you raise only the outside rail of a curve to give it elevation, some allowance should be made for the track settling on that side, when the height of the raise exceeds two inches. For instance should you raise the outside rail of a curve to give it two and one-half inches elevation on a dirt ballasted track without having to take up the the inside rail, the outside rail should have an elevation of about three inches all around the curve if the bed of the track is soft or the fill narrow.

RULE FOR LINING CURVES.

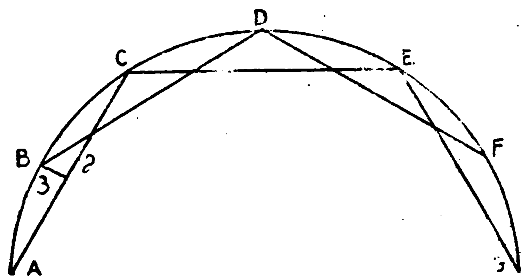


Fig. 24.

EXPLANATION OF DIAGRAM.

The letters A B C to G are track centers of a curve 30 feet apart.
Figure 2 is a 60 foot line with which to ascertain the middle ordinate.
Figure 3 shows where the measurements should be taken to find the middle ordinate.

28. Select any part of a curve track which seems to be in the best line for a distance of at least 60 feet, but do not begin at the points of a curve unless you know postively that the curve

turns off from the straight track without leaving a swing in the line.

Set two stakes accurately in the center of the track, 60 feet apart, and one in the center of the track at the middle of the 60 feet. These three points are shown in figure 24 by the letters A, B, and C. Now stretch a cord tight from A to C, and measure from the center of the cord indicated by the figure 2, to the center stake, B.

The result should be your guide as a middle ordinate for the balance of the curve in either direction from where you commence work. We will suppose this middle ordinate to be four inches. You next move the cord 30 feet ahead in the direction in which you wish to line, stopping at B, with the end you had first at A, and holding the end of cord which was at C in your hand until its center is directly opposite and distant just four inches from the track center, at C. You may then set track center D at the end of the cord which you hold in your hand.

This process may be carried out until you have set track centers for the whole curve.

Every stake set for a track center should be driven into the ground with its inside face or edge touching the cord, and this side of the stakes should be a straight edge if possible, so as to have a uniform center throughout the curve and along the inside face of all the stakes. This will obviate the necessity for using a tack to make an accurate center on the stakes.

After you have set the track centers for the whole curve, procure a gauge which is square and true, and mark on the gauge, with some sharp instrument, the correct center between track rails or middle of the gauge. Place this gauge on the track between the rails and over the track center where you wish to begin lining the rails to place. Then have your men move the track with their lining bars until the center, as marked on the gauge, comes directly over the track center on the stakes. Move the track in this manner at every point where you have set a track center stake, and then go back over it again, taking out any kinks or other defects left in the line, and you will have a splendid and a true curve line on your track, as good as if a civil engineer had set your track centers with an instrument.

Care should be taken not to make any mistakes in measuring the middle ordinates, or in setting the track centers. It will pay to take your time and do the job well, because if properly done (like well surfaced track) it will only need to be retouched in spots ever after.

By commencing at a rail joint, this method of lining a curve may also be applied to the gauge side of the rails, and any defects in the track line can be taken out by moving the rails to place as you go, but the work will not be as accurate or as reliable as by the process first given.

EFFECT OF LOCOMOTIVE AND CAR WHEELS ON CURVE TRACK.

29. Car wheels which are badly worn on the ties, or close to the flanges, or which have the flanges worn sharp, are very unsafe when passing over switches if there is the slightest lip on the rails. They are dangerous also on battered rails, or going around sharp curves, where they are liable to climb the rails and leave the track. Wheels of the kind mentioned have a tendency to hug the rail on their side of the track, and as a consequence make a considerable wear along the gauge side of the ball of the rails. They also wear spots along the top surface of the outer rail on curves, because the circumference of the wheel being the same or worn smaller at the flange than at the outside, the wheel must slip a certain amount in proportion to the degree of curvature, in order to travel as fast as the wheel on the inside rail. When the gauge of the track on sharp curves is the same and not wider than the standard for straight track, the car wheels do not have play enough to enlarge the circumference of the wheel tire upon the outside rail of the curve, and the result is a wearing of the top surface of the rail the same as mentioned above. When the drive wheels of an engine are allowed to run too long without being turned off, the groove worn in the tire often causes considerable damage to track before

the cause is known. Badly worn drive wheels break the frog points when passing over switches, and as a general rule the most of the wear on the rails on curve track is chargeable to the same source.

ELEVATION BALANCE.

30. On curve track where there is not enough elevation or the gauge of track is tight, the car wheels wear off the gauge side of the outer rail, by the wheel flanges crowding against it and this causes the track to spread and become unsafe. If the elevation of the outside rail of a curve is excessive, the rails will wear most from the top surface downward and on the inside rail of curve. It also forces the inside rail below the proper surface.

It does not make the track any safer for trains and lessens the number of freight cars that an engine can haul over them. Especially is this the case when the elevation is excessive on sharp curves at terminal stations where trains run very slow.

LIABILITY OF DERAILMENT.

31. The liability of accident to trains such as the derailment of locomotive or cars is much greater on a curve track than on a straight track,

and a large percentage of the accidents which do happen is chargeable to defects in the rolling stock as well as to the defects in the track itself. Heavily loaded freight cars often leave the track owing to the failure of a truck to adjust itself to the curve of the track, caused, perhaps, by a defective curve roller, and the greater part of the load resting upon one side of the truck.

REDUCED SPEED.

32. Curves of ten degrees or more are not common on the main line of standard gauge railroads. When they do occur the speed of trains should be reduced in proportion as the degree of curve increases.

A CURVE IN A SAG.

33. When a curve is approached from both directions by a heavy down grade the speed of all trains is greater there than at any other point on the track, and for this reason it should have all the elevation necessary to carry trains safely at their greatest speed. Foremen should give such a curve half an inch more elevation and an approach thirty feet longer than the amounts stated in the table for elevation of curves.

CARE OF CURVES.

34. The rails on curves could be made to wear much longer if those which showed signs of wear were transferred to the opposite side of track before they become badly worn. A depression of three-fourths of an inch in the surface of track on the outside rails, or a slight kink in a rail on a curve, or a joint out of line or gauge, will throw every car in a train heavily to the opposite side of the track. For this reason track foremen should keep curve track in the best condition possible.

LINING CURVES.

35. Some foremen have a very bad habit of always lining the curves out. This should not be done. The tendency of engines and cars is to knock parts of the curves towards the outside at the weakest points. If the foreman will line towards the inside of the curve any joints or rails which project beyond the true line of curve, there will not be any necessity of increasing the curvature by lining so much towards the outside.

STRAIGHT RAILS IN CURVES.

36. When iron or steel rails are laid in curve

track without first being curved, or just as they come from the rolling mill, the joints soon project out of line, and by the knocking of the train wheels against the joints they are partly assisted to get back to their original shape, destroying the proper line of curve. Such rails give the cars passing over them a peculiar side motion which makes the track appear very rough, no matter how well surfaced it may be.

NUMBER OF RAILS WANTED ON CURVES.

37. Foremen in charge of laying track where curves are common and of different degrees, should have a good intelligent man to keep ahead of the steel car and ascertain from the engineer's stakes, as nearly as possible, number of rails, straight or curved, and degree of curve for the next iron or steel wanted at the front. This can be done best by the foreman in charge of the steel car having alignment notes of the work as laid out by the engineers, showing the number of feet of curved or straight track and giving the degree of curve. When the above plan is not followed rails can be seen along the road in piles of different sizes behind the track layers where it was thrown off from time to time by the steel car crew in order to go back and get the kind wanted next. Considerable time and labor which could as well have been saved is expended in picking up the surplus rails along the track.

FOREMEN SHOULD KNOW THE DEGREE.

38. Foremen in charge of curving rails should know before hand the degree of each curve and the number of rails wanted for it, so as to have no delay in getting them to the front when called for.

A GOOD CURVE.

39. A curve track is put up properly when the engine and all the cars in a train run smoothly on to the point of a curve from straight track without any shock or jar that would indicate there was a change in the line or surface of the track. All the cars in a train should run around the curve leaning slightly towards the inside rail, and not change this position perceptibly until the straight track is reached again at the opposite end of the curve. Above all things, foremen should keep the surface of a curve track as smooth as possible. In this more than in anything else lies the secret of having a good riding track.

DANGEROUS CARS ON CURVES.

40. I am fully convinced that it is both a fool-hardy and dangerous policy to allow the cars from any road with a 4 foot 9 inch gauge to run on a standard gauge road unless the flanges of

all wheels have "the same clearance" room between them and the rails as is allowed for the standard gauge wheels. The Inter-State Commerce Commission reports for 1889 shows 387 railroads with a mileage of 28,939 miles of 4 foot 9 inchgauge, while of the standard gauge there is 1,030 roads operating 114,148 miles which shows that with all our boasted progress there is yet nearly one-fifth of the railroad mileage of the country which does not conform to the standard gauge although the freight business of all these roads is inter-changeable.

It is a notorious fact that the cars of a railroad with a 4 foot 9 inch gauge are the ones which are oftenest derailed when running on standard gauge track both on the main track and at switches, and on curves, and when not wrecked or derailed they are continually damaging the standard gauge track and spreading the rails out of proper line and gauge. *Their wheels run more on the flange than on the tread of the wheel* and in so doing soon make said flanges very sharp and dangerous, peeling and wearing away the innner side of the track rails and always ready to climb the outer rail or curves, they are derailed by the slightest lip on a stub switch, and often run foul of a frog point.

These wheels have to be changed so often that it adds another large item to the cost of car repairs, and if the whole of the damage to track and other defects that are chargeable to this ruinous

system were summoned up and kept account of, we would have an exhibition of one of the most dangerous and expensive methods of operating railroads.

How often has one of these wide gauge trucks jumped the track and wrecked a train on some sharp curve without leaving a clew for those who come to investigate the cause of the accident. Probably the track will be torn up and everything in confusion and some person will say that the trouble was caused by spreading of the rails or an improper adjustment of the elevation of the outer rail on the curve or something else just as far from the truth.

As a remedy for the foregoing, I would suggest that all standard gauge railroads which interchange traffic should make it a rule to have the wheels on all cars received at junction points, examined and tested with a standard wheel gauge, and those not conforming to the proper specifications should be rigidly excluded, and wheels of a correct pattern should be put under the cars to replace those which are defective, the cost to be charged up to the company owning the defective wheels.

FALL TRACK WORK.

CHAPTER VI.

FALL TRACK WORK.

1. Track foremen will find plenty of work to do during the fall months before the ground freezes, preparing their sections to go through the long winter months with as little repair work as possible. If the weather is good more work can be done (which will benefit the track) in one month before the ground freezes than can be performed during the whole winter.

Section foremen should find all the worst

places in the track and repair them in the best manner possible.

Special attention should be given to improving the surface of the track and putting a perfect line and gauge on the rails.

The roadbed should be cleared of weeds and grass and the ballast along the shoulder of the track and between the rails should he dressed up neatly; joint fastenings should be made tight, and the ditches in all cuts should be cleaned out.

Any rotten ties remaining in the track should be taken out and replaced by new ones.

All new steel should be laid before cold weather. The joint ties should be spaced properly and ballast put under the track, and at other points on the road where steel is not laid good repair rails should be put into the track to replace those which have become battered. Dead grass, weeds and other rubbish should be cut or cleaned away from around the woodwork of all bridges, culverts or cattle guards and the rubbish should be gathered up and burned.

In a prairie country the grass along the right of way on both sides of the track should be burned off clean as quick as it is dry enough, and the tops of the cuts should be burned off *first*, to prevent the locomotives from setting fires on farm lands adjoining. All right of way fences should be examined and repaired and snow fences should be put in good condition to be ready for the first snow storm. All track materi-

al should be piled at the stations, a safe distance from the track, and where it would not cause snow drifts or be liable to catch fire.

Rails, splices and other such material should be raised from the ground and piled upon platforms of old ties so there will be no difficulty in handling them after snow falls on the ground.

All ties, fence posts, engine wood, or lumber, should be corded up with spaces between the piles so that in case of fire it could not communicate to a large quantity at once. Emergency rails and joint splices should be placed at the mile posts along the section where they would be handy in case of broken rails. Much of the fall track work is the same as that done during the spring or summer. But foremen should be particular to do this season of the year all work which can only be imperfectly done in the winter or must wait over until the following spring.

CLEANING OFF THE RIGHT OF WAY.

2. In the latter part of the month of July, or before the weeds growing along the railroad right of way run to seed, the section foreman should commence mowing, and cutting down all grass, brush and weeds from the shoulder of the track out to the right of way limits. This work should be pushed when once begun, and as soon thereafter as the material which was mowed

down is dry enough, it should be gathered into piles and burned clean, or disposed of in some way, without danger to the company's property.

The grass and weeds growing around the ends of culverts, or close to the bridges, should be mowed down, while the surrounding grass is still so green it will not burn, in order that the mowed grass, when dry, may be burnt without danger of the wind spreading the fire, and to prevent other fires from reaching the wood work, when burning off the right of way afterwards. In localities where the sections are long, and only a small force of men is employed, the right of way mowing is sometimes only done for a short distance out from the shoulder on each side along the track, and the balance of the right of way is left to be burnt off later in the fall.

RAISING UP SAGS IN TRACK SURFACE.

3. It frequently happens that a track foreman will undertake to raise the track in a sag up to level surface without any knowledge of the amount of material necessary to put under the track or the time it will require to do the work with the force at his command. In some cases, the time consumed in taking up a sag is so great that other parts of the track which should be attended to are neglected. The following simple rule will enable track foreman to make a very close estimate of the amount of labor and ma-

terial required to bring any sag up to surface.

RULE:—Set two stakes, A and B, close to the track rails and level with their top surface at each end of the sag, as shown in Figure 25. Then set a third stake C at the middle of the sag and in line with A and B, and drive it down until the top of it is level with the tops of the outer two stakes. You can ascertain whether this is the case by sighting over A and B. Measure the height of stake C above the ground and multiply it by the distance in feet from A to B, and again multiply the product by fourteen or sixteen feet for the width of the embankment. This will give you the contents in cubic feet and dividing the whole number of cubic feet by fifty-four will be the number of cubic yards of dirt or ballast which will be required to surface up the sag. If the sag is deeper than twelve inches an allowance of one foot in width for each foot in depth should be made up for the side slopes. An allowance of about one-sixth of the depth below level in some cases should be made on the middle of light sags when surfacing up. This can best be done by leveling a sight board the proper height in the middle of the sag and sighting the track to it from one end, and from that point sighting the rails to where the sag runs out at the other end. A sag, which has only been raised level with the track on eachside of it, will soon become low again in the middle unless made very solid.

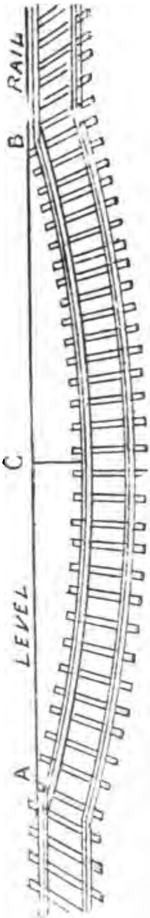


Fig. 25.

NARROW EMBANKMENTS.

4. Many section foremen have a habit of digging holes in the embankment just outside the ends of the track ties when they want a little dirt or ballast to pick up or dress track. This is all wrong. On a mud track if material is wanted for this purpose it should be taken from the nearest cut with the section push car or if the fill is not very deep the foreman should set his men throwing up dirt from outside the bottom of the original fill. There the necessary material can be procured without injuring the embankment, sufficiently to make it liable to wash away or weakening it as a support for the track. The preference should always be given to material from a cut even when the cost is a little greater. A double purpose is served by removing the surplus which accumulates in the ditches and putting it on the fill to strengthen it. Of course, where track is ballasted with gravel, or other like material, dirt should not be mixed with it, but when only a small quantity of material is needed it can be taken from places where the ballast is the heaviest along the shoulder of the track. Whenever any material is taken from a grade or wasted thereon, such places should be leveled off, dressed and finished up in a workman like manner. Never leave unsightly holes along the track. Both sides of the embankment

should be of the same width outside the ties, if possible, and grass should be encouraged to grow along the slopes, because it offers the best protection against weeds and washouts. Section foremen should not attempt to raise up track on high narrow fills in order to surface it. At such places it is always best to pick up and tamp only joints or other low places in the rail, and keep the track in good line until you can get enough dirt or ballast to leave a good shoulder outside the ties after raising up the track to surface.

HAUL OUT MATERIAL FROM CUTS.

5. Where the distance between cuts is short, and the track fill between is high and narrow, section foremen should make good wide ditches in the cuts, and haul out on their push car the material from the ditches, and distribute it evenly on both sides of the track. This work should be done either early in the spring, or late in the fall of the year, or when the facilities for doing other work are not good.

TO REMEDY TOO WIDE AN OPENING AT THE JOINTS.

6. Track is often laid with too wide an opening at the joints, and as a result the ends of the rails batter down very quickly and the joint splices often break and tear apart, owing to the contraction of the rails in extremely cold weather.

Track foremen who are troubled with this state of affairs should try to remedy it at once in the following manner:

Loosen the bolts in forty or fifty joints and pull out all the slot spikes which are used to control the expansion, whether driven in the rail slot or joint fastenings. Then select a space about midway to take out one or two of the rails on each side of the track. Have ready, to replace the rails which you take out, one or two rails the combined length of which will be six or eight inches greater than that of the rails which you take out, allowing this length to be a little less than the total amount you wish to close the joints. Have your men get astride of one loose rail, lift it up and bunt back the track rails on each side of the opening until it is wide enough to admit of putting in the longer rails, then bolt and spike the rails to place, dividing the expansion on the other joints afterwards.

Follow out this method at different points along your section wherever you see it is necessary, and you will have no more trouble with rails tearing apart in cold weather, endangering trains and increasing your responsibility. The rails will wear much longer, and you can keep a much better surface on the track. But foremen should exercise judgment in this matter and be sure that the expansion is so distributed that there will be no danger of making the joints too tight for warm weather.

When you have fixed a piece of track the above away, provide some new ties and put one into track under *the center of every rail joint* which has been moved out of its place on the track ties, when you were shifting the rails.

Both jobs should always be done at the same time and low joints tamped up to surface, the ties spaced properly so that the spikes may be driven in their proper places and prevent track creeping.

BUILDING FENCES.

7. It is sometimes the duty of section foremen to build wire fences along the railroad right of way limits; and as there are many foremen who have had no experience in this branch of work, it will not be out of place to here give a good practical method for performing this duty.

Measure with a tape line from the center of the track to the right of way limits, which is generally fifty feet, and set a stake in the ground. This should be the outside face of the fence posts when set in the ground. Where the track is straight these measurements need be taken only at distances of forty or eighty rods, but around a curve they should be taken every sixty or hundred feet, in order to have the fence conform to the line of the track.

Peel the bark from all fence posts and set their centers sixteen feet apart, when not other-

wise ordered, so that boards may be nailed on them if desired. To line the fence and regulate the distance between posts, use a chain or line two hundred feet long for straight track, and one hundred feet, or less, for curve track. Have tin tags at regular distances on your chain, or tie knots in the line to mark where the center of each post hole should come, and when the line is stretched, take a spade and remove a little of the sod or top surface of the ground opposite the marks on the line as a guide for the men digging the post holes. The line may then be moved ahead.

Set all posts two and one-half feet in the ground, and have the men who are digging, carry a measuring stick with which to determine the correct depth of the post holes, and thus have all the posts of a uniform height above the ground. A good way to save sighting along straight track is to set a post every forty or eighty rods with a temporary brace, and stretch one wire of the fence to use as a guide to set them by.

When putting on the wires, if you are not furnished a wire stretcher, the wire may be tightened by taking a turn of it around a lining bar. Stick the point of the bar in the ground diagonally from you,and pull on the top of bar with the right hand. In this way you can take up the slack.

Fence wire should not be stretched too tight in

warm weather, or it will break when it contracts in the winter. Always put the wire on the farmer's side of the fence posts, except on the inside of curves. Then the wire should be on the track side of the posts, to strengthen the fence. A good brace should be put in at the end of each piece of fence, or at any point where the fence turns an angle at the end of fence, also at farm gates and cattle guards. See figs. 26-27.

Mortice one end of the brace into the top of the corner post, and the other end into the bottom of the post adjoining, where it enters the ground. Provide a board with notches cut into it at distances equal to the proper space between the wires. The wires may be hung in the notches, and the board will keep them in position while they are being fastened to the posts.

Have the men well organized. Divide a gang of sixteen about as follows: Assign two men to lay out the fence; six to dig post holes; four to set the posts; and four to string the wires and fasten them. Move the men occasionally from parts of the work which are the most advanced, to parts which are behind. When crossing creeks or marshy places, it is well to turn the fence in at right angle to end of the bridge and string the wires across on the piles.

Order material as follows: fence wire, one pound for every single wire panel of sixteen feet; staples, one and three fourth pounds for each hundred pounds or spool of wire used.

When spacing wires, have the bottom wires the closest together. For instance, for a five wire fence four and one half feet high, place bottom wire eight inches above the ground; the second wire ten inches above the first, and the other three wires each twelve inches above the last, or the third wire from the bottom could be spaced ten inches above the second, and the top wire fourteen inches above the fourth. The latter is the best method where it is desirable to fence against all kinds of stock. The top of fence posts should not be more than six inches above the top wire of the fence, and all posts when set and tamped solid should be all in perfect line and a uniform height from the ground. When posts are irregular in length, the surplus timber should be sawed off if it amounted to four or more inches, but where the post is only two or three inches too long, the hole may be deepened sufficiently to leave it the proper height when set.

If a post is two or three inches short fill up the hole sufficiently to bring it to the right height above the ground. But should it be as much as six inches too short, do not use it in the fence except at some places where it would answer for a short brace. To regulate the height of fence posts above the ground, have a standard made the correct height and nail square across the bottom of it a cross piece two feet long, which will prevent slight inequalities in the surface of the ground from affecting the height when placed

beside the post. This standard can also be arranged to regulate the distance between the boards or wires as they are nailed on the fence.

A fence with the top wire or top board four and one half feet from the ground is a lawful fence in most of the states.

BOARD FENCES.

8. In building a board fence, the setting of posts and nailing on of the boards, can be done at the same time. Always use the shortest boards to measure from one post to the next one to be set; the longer boards can be sawed the proper length. Nail the boards on the outside of the fence. Several men can be nailing on boards at once, by ending the boards against those last nailed on the adjoining panel. On straight track, sighting posts can be set at the proper distance from the track, every forty or sixty rods ahead of the men digging the post holes. But on curve track, to make a good fence and have it in line, every panel post should be measured from the center of track, and a stake set for it. This is not much of a job, if two men go along the track carrying the tape line stretched from place to place, while a third man sets stakes for the posts. By laying a board against the two panel posts, it lines the place for the middle posts. A bracket, made the proper height from the ground

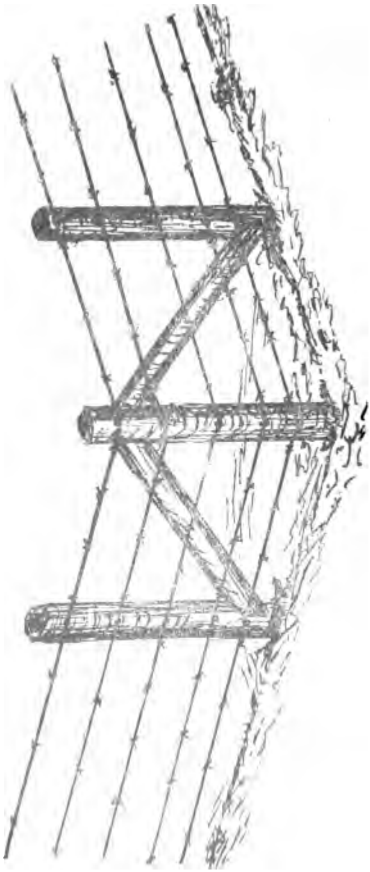


Fig. 26.

Method of Bracing at the ends of Wire Fences; also at farm gates, cattle guards, or other points where Wire Fences turn an angle.

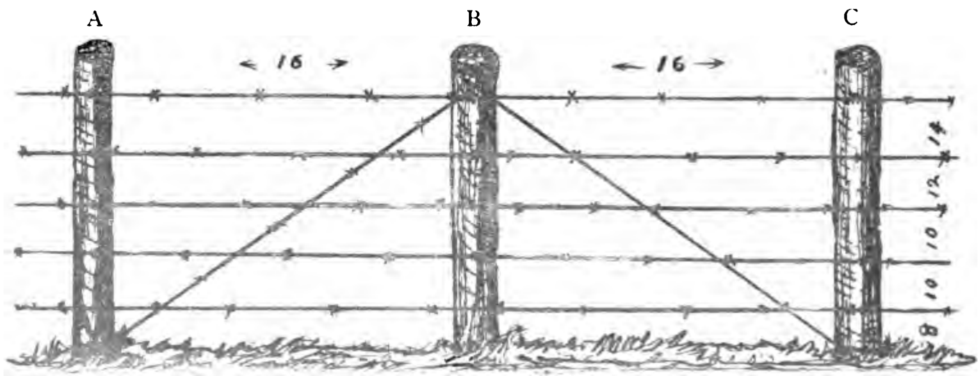


Fig. 27.

Method of staying a Wire Fence to strengthen it, to be put in at intervals of every 20, 30 or 40 rods. Wrap the wire around the bottom of post A, carry it up and around B, and down to bottom of post C. After securing the wire with staples at bottom of post C, take it again around B and finish at A, or use a double wire, and take but one turn on each post.

with projections on it to fit between the boards, making the spaces the correct width, is very handy when building a board fence. It makes a much neater face than when the spacing is done by guess, and saves measuring the spaces.

If board fence is built with the boards meeting on the same side of the post, a batten should be nailed over the joint from the ground to the top of the post.

For a permanent snow fence constructed with posts and boards, the posts may be set about fifteen feet four inches apart, and the ends of the boards can be nailed on opposite sides of each panel post. By this method there is a larger amount of the board available for nailing when putting them up again after being torn, or blown off. It also saves the labor of sawing off the ends of the boards to make them meet square on the post.

FENCE TABLES.

9. The following tables will be useful to foremen, when estimating the amount of fencing material required to build a post and board, or wire fence.

TABLE

SHOWING NUMBER OF POSTS REQUIRED TO BUILD ONE MILE OF FENCE.

DISTANCE BETWEEN POSTS.	NO. POSTS IN ¼ MILE.	NO. POSTS IN ½ MILE.	NO POSTS IN ONE MILE.
8 Feet.	116	331	661
12 "	111	221	441
16 "	83	166	331
20 "	67	133	265
32 "	42	83	166

TABLE

SHOWING THE NUMBER OF BOARDS REQUIRED TO BUILD ¼ MILE, ½ MILE, OR ONE MILE OF FENCE AT A GIVEN NUMBER PER PANEL.

NO. OF B'RDS PER PANEL	QUARTER MILE.	ONE-HALF MILE.	ONE MILE.
4 Boards	330	660	1320
5 "	412½	825	1650
6 "	495	990	1980
7 "	577½	1155	2310
8 "	660	1320	2640
9 "	742½	1485	2970
10 "	825	1650	3300

One sixteen foot fence board contains 8 square feet of lumber. If a lumber estimate is required, multiply the number of boards wanted by eight, and the result is the nnmber of square feet.

EXAMPLE.

4 boards per panel for $\frac{1}{4}$ mile of track.

$$\begin{array}{r} 330 \\ 8 \\ \hline 2640 \end{array}$$

2640 square ft. of lumber.

WEIGHT OF NAILS.

10.

No. of Nails.							
55,	10	penny	common	nails	weigh	one	pound.
45,	12	"	"	"	"	"	"
30,	10	"	fence	"	"	"	"
28,	12	"	"	"	"	"	"

To ascertain the amount of nails wanted to build a given length of fence. Multiply the number of boards by six, and divide the result by the number of nails to the pound.

EXAMPLE.

For ¼ mile board fence 330 Boards 4 per panel.
No of nails per board 6

No. fence nails per pound 30) 1980

66 lbs.

WEIGHT OF FENCE WIRE.

11. The average weight of the wire now used by railroads is very close to one pound per rod for one wire, or about $6\frac{3}{8}$ per 100 feet in length. When making estimates for wire fence, about 10 pounds to the mile of fence may be added for tying, splicing, etc. The weight of staples varies according to the size used. 70 staples to the pound is the size most commonly used in building railroad fence.

A DAY'S LABOR.

12. The average day's labor for one man at building post and board fence, where the boards meet on the post, six to a panel, and the work of setting the posts is included, is about eight to ten panels of fence complete. When the ends of the boards lap on opposite sides of the posts, thirteen to fifteen panels can be constructed by one man in a day. Building a post and wire fence, posts one rod apart, and four strands of wire, a man can construct about fifteen panels in a day; but a great deal depends on the conditions under which the work is performed, the quality of material used, and the quality or general excellence of the work when finished. The results obtained from a man's labor, depend, first, on his intelligence; next, on his willingness to

work; and lastly, on his physical endurance. These three requisites should always be considered by a foreman when employing men; and when possible he should always choose for his men, those who possess all of the qualities mentioned.

WINTER TRACK WORK.

CHAPTER VII.

WINTER TRACK WORK.

1. There are many kinds of track work which the section men should do during the winter months on northwest roads, all of which are important, and assist materially to lighten and advance the work of the following spring and summer.

In the early part of the winter, when the cold weather has contracted the rails, its effect on the rail joints, bolts, and splices should be noticed by the foreman, and all loose bolts should be tight-

ened up, and broken or cracked splices should be replaced by good ones.

All open joints should be closed to the proper space, especially in the switches, to prevent the ends of the rails from becoming battered, and to save car wheels from breaking when passing over wide openings between the ends of the rails, as often happens in cold weather. All battered rails should be taken out of the track and replaced by good ones. Where the number is so great that they cannot all be removed in a short time, good repair rails and splices should be distributed every mile or two along the section, so that when snow on the track, or bad weather interferes, broken rails or spikes can be replaced without any difficulty or unnecessary delay. As the winter advances, all good weather should be taken advantage of, and every spike above the rail or flange, or leaning from it, should be knocked down to place, and all of the track should be brought to a perfect gauge.

Cleaning switches and yard tracks, and flanging out the main track after snow storms; shimming track, peeling the bark from ties, distributing ties for spring work, opening up ditches and culverts, etc., all add to the section foreman's labor, and it requires a man of good judgment and energy to keep all of his work done properly at the right time and place.

If a foreman keeps the loose spikes knocked down to place, and a good gauge on his track,

he will be surprised at the splendid line which he can have on his track the following summer, and trains will ride over it without that disagreeable side motion of the cars which knocks the line and surface out of the track, and is so fatal to the comfort of passengers.

SHIMMING TRACK.

2. Shimming track is a very important kind of winter work on northern railroads, and should be done with a view to keeping straight track level, smooth and safe, and the proper elevation of the outer rails on curves.

Shims are placed under the track rails to raise up the low places to a smooth surface, and care should be taken to bring the rails to their proper place with the *spirit level*, where the track has heaved up. All shims over a quarter of an inch in thickness should have holes bored through them for the track spikes. This can best be done by boring the holes through a block of straight grained hard wood, six inches wide by ten inches long, and splitting off the shims as thick as needed.

The top surfaces of the track ties should be adzed off level, especially where there is a groove made by the rail. This is necessary to give the rails a solid foundation, preserve the correct surface, and prevent the shims from breaking.

Shims should never be placed lengthways under the rails, because in that position they increase the height of the rail without widening the base. Section men cannot always see them, and they are liable to slip out of place, and by so doing weaken the support, and may cause a broken rail.

Where the shims used are over one inch in thickness, spikes seven or eight inches long should be used to secure the rails, and where thicker shims are used, old rail splices should be spiked on the ends of the ties and against the outside of the rails for braces. These braces should be spiked on every second, third or fourth tie, in proportion to the height of the shims.

To shim two or three inches high, plank of the proper thickness, sixteen feet long, should be cut in halves and spiked to the ties with boat spikes. For four inch shims put a one inch shim on top of a three inch plank, and for five inches use a bridge tie on top of the track ties.

All high shimmed track should be watched closely, and thinner shims should be used to replace the thick ones as fast as the heaved track settles in the spring. Shims should not be removed from track until all heaving has gone down, except where they put under the rails to level up low joints or other spots which were left over in the fall of the year. When the rail which has shims under it is higher than the track either way from it by the thickness of the shims,

you may remove them as the heaving has all gone out of the ground. Many foremen have spoiled a nice piece of track by removing the shims and tamping the ties as soon as the frost was out to the bottom of the ties. All good shims, shim spikes and braces, should be put away in the tool house every spring, and saved for use another year. And any planks which were used for shims in the manner here mentioned, may be put in service during the summer on highways or private wagon crossings.

HEAVED BRIDGES AND CULVERTS.

3. Pile bridges and pile culverts need careful watching in the winter season, and whenever the section foreman finds them heaved up out of surface or line, the bridge carpenters should be promptly notified. In some bridges and culverts the piles which heave up have to be cut off, and that part of the bridge or culvert must be lowered to correspond with the track on each side of it. Unlike the track in cuts, or on dumps, some piles which heave up in the winter do not settle back to place again when the frost goes out of the ground, and shims have to be put under the caps or stringers, to keep the bridges up to surface during the summer. The greatest danger is to be apprehended where the piles in a bridge heave up irregularly, as when only one or two piles heave in a bent, or when the piles heave up

i i opposite corners of two different bents. This often happens where the piles are driven in deep water, as the ice which freezes to them lifts them up and should, therefore, always be cut away by the track men before there is danger of its doing so.

REPORT AMOUNT OF SNOW.

4. Section foremen should ascertain the condition of the track in their charge immediately after every snow storm (or wind storm) which would be liable to drift snow upon the track, and report to their roadmaster the depth and length of snow drifts in all the cuts on their sections. It is of the greatest importance that snow reports be sent promptly to the roadmaster by telegraph in order that the officers of the road may be able to make necessary preparations to clear the track. When there is no snow in the cuts on your section, report your section clear of snow.

SNOW ON SIDE TRACKS.

5. Section foremen should clear away the snow which has drifted upon side tracks as soon as possible after a storm, and the snow on switches and in frogs and guard rails, should be shoveled off and the track for the full length of

the switch lead and moving rails should be swept clean. This work should never be delayed because all freight trains will need to do switching as soon as the road is open for traffic.

SNOW IN CUTS.

6. During the winter months when snow falls or is drifted into cuts to a depth of two or more feet, section foremen should take their men just as soon as possible after the storm and remove from the track sufficient snow at the ends of all drifts, to leave a clean flange and a clear face of snow, at least 18 inches deep, at both the approach and run out end of the drift. It is a notorious fact that a great many engines, when bucking snow, run off the track when coming out of, or running into a snow drift. This is generally caused by hard snow or ice in the flanges, as the engine, on being suddenly relieved of the weight of the snow, easily mounts the rail on a hard flange way, and runs off the track.

FLANGING TRACK.

7. Whenever the track becomes full of snow in the winter, and needs flanging out, section foremen should take their men and flange out the track at the tops of the heaviest grades first,

and next, at all places on their sections where it is most difficult for an engine to pull a train. Always leave till the last those parts of your section which needs flanging least, such as high dumps, level track or sags between grades.

OPENING UP DITCHES AND CULVERTS.

8. On roads where snow lies on the ground during the winter months, section foremen should open up all ditches, culverts, and other waterways which pass along or under the track. Culverts, which are apt to be covered with snow in the winter, can easily be located when the thaw comes, if a long stake is driven close to the mouth of each cvlvert early in the fall of the year before any snow falls on the ground.

In cuts that are full of sonw on each side of the track leaving only room enough for trains to pass through, foremen should make a ditch in the snow when it begins to melt in the spring, about six feet from the rails on each side of the track so that when the water begins to run it will not injure the track by running over it.

SNOW WALLS.

9. If you have any snow fences for protection along the cuts on your section, watch them closely and when ever you find a fence which has been

drifted full of snow or nearly so, build with blocks of snow, taken from the inside face of the drift, a wall four feet high along on the top of the highest part of the drift. As long as the weather remains cool a wall built of blocks of snow will give as good protection to a cut as the same amount of ordinary snow fence would. Make snow walls strong and thick and increase their height on the worst cuts in proportion to the force of men that can be spared to do the work, and use double lines of snow wall fifty feet apart where they will be beneficial.

SNOW FENCES.

10. On the majority of northern railroads the amount of snow which falls upon the ground during the winter months is not so great as to require the building of snow sheds, but to protect the cuts along the track from filling with snow, fences are built along the tops of the cuts at a sufficient distance from the track to catch the snow when it is drifted, and prevents it from being blown into the cuts and blocking the track. The efficiency of a snow fence as a protection against snow depends on its strength, durability, height, how far it is from the track and the manner in which it is arranged along the top of the cuts.

The writer has had some experience with snow and snow fences, and will here offer a few sug-

gestions which may be useful to those interested.

A snow fence, no matter how well made, or of what material, will rot and become useless in eight or ten years, at the latest. The yearly cost of repairing snow fences, the first cost, and the interest of the money invested, should all be considered before putting up a snow fence on any railroad cut. And where the work of grading down a cut on each side of the track, so that it will not hold snow, can be done for an amount of money equal to the cost of the items above referred to, the grading of the cut should be done in preference to the building of a snow fence. In many sections of the northwest, a cut which is only two or three feet higher than the track rails can be graded from the right-of-way limits down to a level with the bottom of the track ties, and the dirt wasted on the fills near at hand for less than it would cost to maintain a snow fence on the same cut.

Even when the cost of putting a cut into such a condition that it will not hold snow, is somewhat greater than that of maintaining a good snow fence, the difference is in favor of the grading on account of the benefit the track derives from it. Snow fences are not needed at deep cuts, which from their top slope back into a valley within a short distance from the side of the track; nor are snow fences much good as a protection where the ground slopes with an incline off from the track unless the fence is close

enough to carry the wind above the cut, or catch the snow before reaching the cut. Snow fence is not needed on cuts where heavy timber or underbrush grows close along each side of the track, the only snow in such cuts being that which falls directly upon the track and cannot be prevented. But where the ground is level for some distance from the track, or on a gently rolling prairie, cuts are liable to fill up with snow if not properly fenced. Snow fences should be set up at such a distance from the track that the edge of the snow drift inside of them will not reach within thirty feet of the track when the fence is drifted full. Set the fence about eleven or twelve feet from the track for each foot in heighth of fence The heighth of the snow fence should regulate its distance from the track. If a snow fence is set too far from the track for its heighth, the wind, after passing over the top of the fence, soon strikes the ground on the inside of the fence, and gathers all the snow before it into the cut, and part of the snow which blows over the fence is also carried upon the track.

A snow fence is seldom set up on each side of the track unless the road is so situated as to be exposed to storms from both directions.

Storms from the northwest, north, and northeast are the most prevalent throughout the northwest, and as a general rule the north sides of railroads running east and west and the west sides on roads running north and south need the

most protection from snow and need the most snow fence. Where two snow fences are put up on one side of the track, they should run parallel with each other, and there should be a space of at least 100 feet between them. Unless a very large quantity of snow is drifted the outside fence will hold it all.

Very good results have been attained by setting out the snow fence next to the track in the following manner. If the snow fence is of ordinary heighth, set it up seventy-five feet from the nearest track rail. Enough of the snow fence should run parallel with the track to reach the full length of the cut, no more. After this part of the fence is up, turn a wing on each end of it, approaching the track gradually until the extreme end of each wing entends 100 feet beyond the end of the cut, at a distance of about fifty or sixty feet from the track rail.

When a cut ends abruptly on the beginning of a high fill, the wing on that end of the snow fence should be turned in towards the track before the end of the cut is reached, or at least soon enough to protect the cut from a quartering storm. A snow fence built parallel with the track and without a wing on the end of it, is of very little use when a storm blows nearly along the track, as most of the snow on the inside of the fence is apt to be blown into the cut. New ties which are received for repair of track the following spring, can be distibuted and used advan-

tageously to make a temporary snow fence on cuts where needed. The ties may be laid along in line with their ends lapping each other, about one foot slats or pieces of board can then be put across the ends of the ties where they lap and a new line of ties laid along on top of them until the snow fence is of the proper heighth.

"BUCKING" SNOW.

1. Clearing the track of snow in the winter really belongs to the roadmaster's department, but as this book is intended to instruct young men who may fill that position at some time in the future, I cannot refrain from writing upon a subject which is of so much importance to railroad companies who are troubled with snow on their roads to a greater or less extent every winter.

No man is so well qualified to buck snow as he who has had some experience at it, and no man should be trusted with full charge of a snow plow outfit unless it be known that he understands the best methods to be employed in opening up the road for traffic after a blockade. The man in charge of a snow plow outfit should be informed of the exact condition of the road, the depth of snow, the length of drifts, and the location of the same, as nearly as possible, before starting on the road. He should have good, live engines,

and willing engineers. The plow itself should, like the engine and engineer, be the best that can be procured and of a pattern that could throw snow out of a cut eight or ten feet deep. Small plows, fenders, or other make-shifts which are only good to clean the rails of light snow, or gouge a hole through a big cut should be left at home, and not taken out to buck snow. When there is a large quantity of it to be moved, the extra time and labor expended in shoveling and pulling such craft out of the snow would purchase a good plow in one trip over the road. Another engine and car, with a conductor, train crew and shoveling gang, should follow close behind the snow plow during the day time, and should be coupled in behind the plow when running after dark. The second engine should be used as a helper in striking deep snow, and to pull out the plow engine whenever it is stuck fast in a snow drift. All cars attached to the helper engine should be left behind on the clear track when both engines run together to buck a drift of snow. The pilot should be removed from the engine which is used for a helper, so that a close coupling can be made when both engines are used together. The less slack there is between two engines coupled together the less liability is there of the hind engine pushing the front engine off the track. This is most liable to happen on a curve track, or where hard snow is encountered. Never allow two engines to buck snow

with a long car coupling between them, or with a caboose or other car between the engines, as either arrangement endangers the lives of the men on the train and often results in a wreck. There is no necessity for using two engines behind the snow plow to buck snow which one engine can as well throw out. It the snow is not too hard, one good heavy engine and plow will clear the track of a snow drift three to five feet deep, and from five to eight hundred feet in length, at one run. *

TWO LOCOMOTIVES.

2. Two good locomotives coupled together behind the plow, if managed properly, will remove any snow which it is advisable to buck. Snow drifts which are higher than the plow cannot be cleared from the track successfully without first shoveling the snow off the top of the drift, except when the drift is very short. Where the top of the snow drift is shoveled off,it should be opened wide enough to allow the plow to throw out of the cut the snow left in it. On roads where a flanger is used and made to pull

*On account of the invention of the rotary snow plows it is not likely that snow plowing with a plow on the front of a locomotive will be done to any great extent in the future, especially where cuts are deep and long, and snow is hard. But when the snow is soft, and not too deep on the track, the old way of getting rid of it is still apt to be practiced.

behind an engine on a train, it should be sent with the snow plow helper, and used to clean out the snow left between the track rails by the snow plow. When the snow is reported hard those in charge of snow plow outfits should be very careful to have their engines and plow in as perfect condition as possible. They should run no risks; every snow drift should be examined before running into it, and each end should be shoveled out enough to leave a clean flangeway and a face that would let the plow enter under the snow and keep it down upon the rails. The tendency of hard snow is to lift the plow up over the top of the drift and throw the engine off the track. Whenever the ends of the drifts are not faced as before mentioned, there is always great danger when entering or leaving short, shallow drifts of hard snow, while on the contrary, there is little or no danger in plowing soft deep snow at the greatest speed the engine can make.

The engines with a snow plow outfit should always take on water and fuel to their full capacity at every point on the road where a supply can be obtained, no matter whether it is liable to be used or not. When it is at all probable that progress will be slow on account of hard or deep snow, a car loaded with coal should be taken along by the helper engine. If there is plenty of snow the supply of water can easily be made in the engine tanks by commencing to

shovel snow into them before they are more than half empty.

A PIECE OF STEAM HOSE.

3. Every snow plow, engine, and helper engine should be supplied with a piece of steam hose which can be attached to the syphon cock and reach from it to the water hole in the back of the tank. With this hose an engine steaming well can quickly make a full tank of water from snow shoveled into the tank. It is also useful to thaw out the machinery, or clean the track rails of ice.

LENGTH OF RUNS.

4. In plowing snow the length of runs and the speed of the engine should always be in proportion to the depth and length of the snow drifts. If the drifts are deep and long, and likely to stick the plow, a good long run should be taken on the clear track, so that the plow engine may acquire its greatest speed before striking the drift. A good engineer who has had some practice in bucking snow, will so handle his engine that very little shoveling by the men will be needed.

It is not advisable to start out on the road with a snow plow outfit during a heavy storm,

but everything should be ready to make a start as soon as the storm is over. The snow plow should be attached to the best and heaviest engine in service on the division where it is used.

The man in charge of a snow plow outfit should use his best judgment and have his wits about him at all times, that he may not be caught on the road with a dead engine, or be wrecked and block the road for other trains. It is much better for the company's interests, and those of all others concerned when all accidents are avoided even should it take much longer time to open up the road.

The engineer of the snow plow engine should sound the whistle frequently when approaching a cut, so that section men if working there, will be warned in time to get out of the cut. When the snow plow is making repeated runs for a big snow drift, the signal to come ahead should never be given until all the snow shovelers have left the cut. It is very difficult for men to climb out of a cut where the snow is deep, and many accidents have occurred where approaching trains have failed to warn the men in time, or where the men have neglected to look out for the danger until it was too late. If the men with the snow plow are always on the alert, and careful and conscientious in the discharge of their duties, the safety of all concerned will be assured and the work will progress rapidly.

PREPARING DRIFTS.

5. When a snow drift is so long and deep that it may stick the snow plow twice, the better policy is to shovel out snow enough from the approach end of the drift to enable the snow plow to go through in the second run. In this way the labor of digging out the engine a second time may be avoided.

All very hard snow should be broken up by the men and the crust thrown out before striking it with a snow plow. The shock felt when a snow plow strikes a hard drift is sometimes very great, and often damages the machinery, or knocks the plow from the track. The force of concussion may be materially lessened by having the men clean a good flange way, and then shovel out of the face and top of the drift enough snow to make a gradual incline of about one foot to the rod. Besides reducing the force of the shock the above method of preparing a hard snow drift enables the snow plow to open a much greater distance at a run.

GENERAL INSTRUCTIONS.

CHAPTER VIII.

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BOARDING ACCOMMODATIONS.

1. Track foremen should always see about securing boarding accommodations for the men working under them. Do not make a favorite of any particular house in a town, but select the hotel which will give the best accommodations the cheapest.

The wages of track laborers as a general rule are low, and very few of these men can pay their board in advance. For this reason foremen should see that board bills presented by hotel keepers against any of their men are properly signed, corrected, and sent into headquarters promptly at the end of every working month, and when a man is discharged, if he is in debt for board, the amount of his bill should be sent in with his check to the superintendent to be de-

ducted therefrom. By paying particular attention to the foregoing instructions, track foremen will always be able to more readily secure men when wanted. The hotel men will not refuse to keep them, and you will save yourself and the company's officers a great deal of annoyance and useless correspondence. Never keep at work for you a dead beat or an habitual drunkard, and you will materially assist in bettering the condition and reputation of men employed in the track service.

DISCHARGES.

2. Upon the day on which a man is discharged the foreman should make out his time in full on the time book, and write opposite his name on the time book, "discharged," or the letters C. G., which means certificate of time given.

The foreman should also fill out a discharge check, using the regular blank form for that purpose. The man's name *should be written in full* on the discharge check and spelled in the same way as on the time book. His occupation, number of days worked, and amount due him should also correspond with the same on the time book. The discharge check should be signed by the foreman and forwarded to the roadmaster for approval. A board bill should also accompany the discharge check whenever there is any de-

duction to be made from a man's wages for that purpose.

Foreman should not discharge any of their men *without sufficient cause*, except when they have received an order to reduce their force, nor should a foreman keep any more men than the regular force allowed him, without orders from the roadmaster.

RIDE OVER YOUR SECTION ON THE ENGINE.

3. Section foreman should take an occasional ride over their section either on the engine or on the back platform of the rear coach or caboose of a train; and while riding over the track they should not make a pleasure trip of it, merely, but should watch closely how the cars ride, and *note all the worst places in their sections*, and note what causes these places to affect the smooth running of the train. A train running at the speed of 45 miles per hour does not ride as smoothly as a train which only travels 20 miles per hour on the same track, because the cars which travel the slowest have more time to get righted after the wheels meet with a place out of line, level, gauge, or surface, while the fast train may meet with, and pass several of these slight obstructions within a second of time, thus having no time to regain its balance. When a train runs along smoothly for a distance and suddenly

swings to one side, if it be on a straight track, that place is either low on that side, or is badly out of line or gauge. If the train be on a curve, and the car swings heavily toward the higher rail, there is not enough elevation in the curve at that point. If the car swings toward the inside rail of the curve, there is too much elevation at the outer rail at that place. A low joint on the inside rail will cause the train to swing to that side, and the striking of the wheel flange against joints that are hooked in out of line on the outer rail will also throw the car toward the inner rail. A foreman can soon become expert in distinguishing the slight difference in the motion of the car as it swings to either side of the track, and tell the cause by examining the bad places in the track soon after riding over it on the train.

FOLLOWING TRAINS.

4. Track foremen should not, at any time, secure their hand or push cars behind a moving train to save the labor of pumping or pushing them. Many serious accidents have happened from this cause. If a train should slacken speed, or suddenly stop, with a hand car attached, it would be hard to prevent the car from going under the coach or caboose, and the men on the car might be injured or killed.

ACCIDENTS.

5. All personal injuries to men working in track service should be reported on the proper blank form by the foreman to the roadmaster, and all accidents resulting in damage to the railroad company's property should also be promptly reported to the roadmaster. When there are no suitable blank forms a written report should be made.

GO OVER TRACK.

6. Section foremen should always in very stormy weather go over their sections and examine *all culverts, bridges and other places liable to wash*, and report condition of track to roadmaster. In going over their section, track foremen should be very thorough in their examination of everything in their charge. See that the telegraph lines are in good order; if they arenot, repair them where you can, and report to train dispatcher, or roadmaster, any defects that may need the service of the telegraph line repairer.

Foremen should also notice the condition of all snow or right of way fences, especially the latter, and repair all breaks in them as soon as found. Gates left open by farmers should be closed and secured. *Unreliable men, or those ig-*

norant of their duties, should never be detailed to patrol the track.

RAISE UP THE WIRES.

7. When telegraph wires are found down after a storm, section foremen should hang them high enough on the poles to insure their working properly, and prevent cattle or teams crossing the track from running against them.

EXTREMES OF TEMPERATURE.

8. Whenever the temperature changes suddenly there is always danger whether the changes be to extreme heat or extreme cold. Section foremen should be very particular to go over and examine all the track on their sections to discover places where track has been kinked and thrown out of line by the heat, or splices broken and rails pulled apart by the extreme cold. Foremen should remember that accidents of the kind mentioned are liable to happen at any point on the road, even where the rails seem to have the proper allowance for expansion, because the change of temperature may come on quickly. Places where the ballast is light, or where the track is not filled in between the ties, are the most liable to be affected.

TRACK JACKS.

9. Every section foreman should have a track jack along with his other track tools, and he should always carry it with him on the hand car, and have it ready to use whenever it is necessary to raise track.

There are few things that look more ridiculous, than three or four men making futile efforts to raise a rail of track, with a long bar or track lever, and a block of wood which is either too high or too low. The ingenuity or ignorance of the whole gang is displayed a score of times during the day, whenever the block will not do to raise the track to the proper height, and valuable time is lost in trying to find a stone, a chunk of wood, or a spike to increase the leverage, and which is seldom or never thought of until the moment it is wanted. Sometimes the spikes are pulled out of one or two ties in every rail length, and the track is raised from the top of the ties. This way also causes a considerable loss of time, pulling the spikes and respiking the ties, besides the injury done the ties, when the old spike holes are left open to rot the wood. Raising track with a lever, pulls the rails out of line much more than raising it with a jack, and makes it more difficult to get back to place, often loosening the spikes where the ballast is heavy, and the track is laid with soft ties.

A good track jack is one of the best and most

economical tools that can be used on a railroad.

In order to avoid accidents when track is being raised, the track jack should be set on the *outside* of the rails. In this position the pilot of an engine, if it should strike the jack, will knock it clear from the rails. But there is no necessity of using a track jack immediately ahead of the passage of trains, or when they are due at that point, and the men can be employed at other work for the time. A track jack placed inside the rails which could not be removed in time, caused the derailment of a passenger train on the old colony railroad and ten persons were killed.

THE SPIRIT LEVEL.

10. Foremen should never go out on their sections to pick up track or surface it without taking the spirit level with them. It should be used continually, especially on track which was never ballasted, or which was surfaced hurriedly without using a level. Never listen to ignorant or conceited track foremen, who will tell you that they can put up as good track without using the track level. It is impossible. If you have surfaced a piece of track to a perfect level, then you can sight the depressions in the surface without using the spirit level, when going over it a second time, if the track has not become rough.

It is the rule more than the exception, that

where a track is newly laid and ballasted with dirt, the surfacing is poorly done, and the spirit level seldom or never used.

Section foremen in charge of new track laid on dirt should make it their business to improve the line and surface as fast as possible with the force allowed them, before the track settles, or the dirt becomes a solid mass. While the ties and iron are new is the time to make a good track.

SURFACE BENT RAILS.

11. In wet cuts, or other low places, the track often becomes very rough, and the ties sink into the mud in places. The rails then, if of light weight, become more or less surface bent before the track can be raised up, or repaired properly. If the surface bent rails cannot be replaced by good rails before the track is ballasted up they are apt to cause the section foreman much trouble in trying to make them remain in true surface, if he does not understand how to straighten them. This can best be done by the following method: If, for instance, a rail bows up at the quarter or the center, make the ties solid at each end of the bent place, then remove enough material from under the ties, where the rail is bent, so that the weight of an engine passing over the rail will bend the bowed place, just as much below level, as it is then above.

After a train goes over you will generally find the rail has resumed its proper shape all right. If the bend in the rail is downward, hang the center of the bent place upon one or more solid ties, according to the length of the bend, and allow the balance of the track under the rail to remain as it was. Joints which have been allowed to remain low for some time, often cause the rail to become surface bent in the short quarter, and they are very difficult to keep up ever after, unless the kink is taken out of the rail.

A loose joint tie, in gravel or sand ballast, will soon pump out enough gravel to cause the rail to bend a short distance from the end, unless it is noticed by the track foreman, and taken care of at once. When the track foreman wishes to straighten any surface bent rails, he should always signal the first train, and have it run slowly, because there is danger of the rails breaking where they are not fully supported. Surface bent rails, which are so bad that they cannot be straightened while in the track, may be taken out and fixed with the curving hook and lever.

LOW JOINTS.

12. When picking up low joints in gravel or stone ballasted track, particularly where the depressions are only slight, track foremen should always use tamping bars, or tamping picks, according to the nature of the ballast, to tamp up

the track ties to the proper surface level.

There are many things other than a weak foundation which make low joints in track. Loose bolts in the joint fastenings make low joints, because they allow the joints to bend down under the weight of the engine and cars. Bad gauge and line make low joints, because the cars, when trains run fast, are thrown heavily from one side of the track to the opposite, and the joint being the weakest point is liable to be affected the most. A wide space between the ends of the track rail also make low joints, and assists the car wheels to batter the ends of the rails.

When rails are laid on soft wood ties, or when the ties, have commenced to decay, you will generally find that a low joint is wide in the gauge between the rails. Make low joints a scarce article on your seetion of track, and you will quickly have a good track, and a good reputation as a track foreman.

EXAMINING TRACK.

13. When the track rails on a section become badly worn, and need to be repaired often, or when the ground is frozen solid in winter, section foremen should go over their sections daily, and examine the track thoroughly for broken or cracked rails, removing from track such rails, and replacing with good ones.

It is the duty of foremen never to deviate from this rule unless a regular track walker is employed for this purpose, or when they have orders from the roadmaster to the contrary.

The section foreman is responsible for the condition of the track in his charge, and he should do everything in his power to contribute to the safety of passengers and trains passing over it. Report all broken rails to the roadmaster as soon as found, giving brand, weight, age, etc.

SCARCITY OF REPAIR RAILS.

14. When repair rails are scarce, and a foreman cannot procure enough to exchange for damaged rails in his main track, he can with only a couple of extra rails keep his track perfectly safe by commencing in time to bring into station the worst rails on the main track.

Take the extra rails out on the section, if good and of the proper length, exchange them for two battered rails, bring the two battered rails into the station and put them in the yard, or in track some place near the station, and get two more good rails. These you take out on section as before, and exchange for battered rails. In this way a foreman may exchange four or five carloads of rails, or about one mile of iron or steel, until he receives a supply of repair rails.

Battered rails are safer within half a mile of a station at the track foreman's headquarters, than

out on his section, because trains run slower there. Battered rails are less liable to break near the station. They are also much easier watched, and taken care of. When repair rails are received the battered rails can all be removed at once.

CHANGING BATTERED RAILS.

15. The best method for changing rails which have become unfit for use on the main track, when the rails furnished for repair are of a different length from those in the main track, is as follows.

Put in track near the station a string of repair rails, and take out rails of a proper length to change the battered ones out on the section. In order to do this right, and save unnecessary expense and labor, always try to have the number of repair rails you put in track replace a greater or less number of rails of a different length without any cutting. If you have not the right number of rails without cutting one, use a number of rails that will give the least waste.

EXAMPLE.

15, 26 foot rails equal 390 feet.
13, 30 foot rails equal 390 feet.

OR

7, 30 foot rails equal 210 feet.
8, 26 foot rails equal 208 feet.

As will be seen in the above example, there are

only two feet to be cut from the last 30 foot rail of the 7 to replace 8, 26 foot rails, and for this waste a foreman should select (if he has it) a rail battered on the end, that will give the required 28 feet of good rail.

EXTRA WORK.

16. It is customary on most railroads to call upon the trackmen to do extra work occasionally, such as assisting the telegraph line repairer, the bridge carpenters, pump repairers, etc., whenever these gangs cannot well perform the work alone, or when a sufficient force of men cannot be procured to do the necessary work.

Track foremen should not assist with their men at any kind of extra work without orders from the roadmaster. When such orders are received the track foreman should only give the amount of help required, using all of his men or only part, as is necessary. Never employ all of your force when a less number of men could do the work as well, unless your orders require it. Charge accurately on the work journal, and to the department to which it belongs, all extra work performed by your men during the month. Whenever you do any extra work, for which there is no printed heading on the work journal, put down the time in some column which you are likely not to have any occasion to use for the work specified in it, and state, in writing in the

same column where you put the time, what the labor was.

TRAIN ACCIDENTS, ETC.

17. In case of an accident to a train, the section foreman who is called should take his men and tools and go to the place, no matter whether it is on his section or not, and give all the assistance possible. Foremen should obey the conductor of the train, and work under his instructions until the arrival of the roadmaster, or until they receive other orders. Section foremen should not wait for orders from their roadmaster to do any extra work which they know to be absolutely necessary, but should do the work at once, and remain out with their men until everything is safe. If a foreman is notified by train men or others of something wrong on a section adjoining his own, such as a broken rail, a fire along the right of way, or the telegraph wires broken or down, he should make all possible speed to get to the place of danger *without questioning his right to go*, because it may not be possible to notify the proper foreman, and any delay may cause the company considerable loss.

AT WRECKS.

18. Whenever there is a wreck on the road,

the foreman on whose section the accident happened, should keep an accurate account of the labor and material expended in repairing the damage done to the track. This account, together with the one of the damage done to rails, ties, spikes bolts, or to the grade, should be put in the form of a report, and promptly sent to the roadmaster immediately after the track is repaired. Time of men working at a wreck should be charged to that account on the work journal.

WATER STATIONS.

19. At all the water stations the section foreman should note the amount of water in tanks when passing, and where wind engines do the pumping, they should be oiled often, and any defects in them or the pumps should be repaired, if possible, or reported by telegraph to the person in charge of such work. Section foremen and their men should pump water into the tanks whenever the wind engine fails to supply enough for trains. When it is necessary to pump by hand, foremen should commence to pump before there is any danger of the supply in the tank being exhausted. Where steam pumps are to furnish the water for trains, section foremen should assist the man in charge to do any necessary repairing which he can not do alone. Section foremen should always be ready and willing to get out their men *day or night*, to do work

where their services would be valuable to the company.

TRESPASSERS.

20. Foremen should see that no person is allowed to erect dwellings, stables, or other buildings within the limits of the railroad company's right of way, or in any other manner trespass on the company's property, without permission from the roadmaster or superintendent.

PROTECT FENCES.

21. When burning grass, weeds, or other material along the right of way, foremen should be very careful and protect the fence from fire. Never go away from a place where you have been burning rubbish, and leave any fire behind you, no matter how small the fire, or how harmless it may appear. It is always *dangerous* until extinguished. If part of a fence should accidentally be burned, or destroyed from any cause, the damage should be reported at once to the roadmaster, giving a correct list of the property destroyed, and location of the same, so that material to repair the damage can be sent there promptly.

RAILS OF DIFFERENT HEIGHT.

22. All rails of different heights, where they meet at a joint, should be connected with a step splice, and an iron shim should be put under the base of the low rail to give an equal bearing with the high rail. The iron shim should have slots punched in the sides so that spikes can be driven in to keep it secured in place.

EXPANSION BLOCKS.

23. When it is necessary to use short pieces of rail, called expansion blocks, to close up an open joint between the ends of two rails, the holes in one end of the splices should be lengthened so that the joint can be full bolted and properly secured. The expansion block in a joint should always rest on the center of a sound tie.

SWITCH STANDS.

24. All switch stand targets should show blind, when locked on the main track, also on all tracks running parallel to the main track, when connected at both ends. The switch target should show the red signal for an open switch when thrown for a spur track, and the switch should be thrown back to position on the

through track, and kept locked, except when the spur track is in use.

ABSENT FROM DUTY.

25. Track foremen should never be absent from duty, unless by permission from their roadmaster, except in case of sickness or from some other unavoidable cause, and in such cases the roadmaster should be notified immediately.

EMERGENCY RAILS.

26. When it is possible to avoid it, I would recommend that track foremen leave neither track tools nor material of any kind out along their sections over night. But on roads where snow troubles in the winter time, and section foremen have long sections, it is a good policy to have good repair rails, with splices bolted to them, placed at convenient distances, one or two miles apart, along the section, where they can be easily reached. These rails can be used in case of an emergency to replace a broken rail in the track, and the splices will also be handy to replace broken ones, without the necessity of going perhaps several miles through snow drifts, back to the station, for the material wanted. To prevent the rails or splices from being covered with snow, they should be secured on posts set

with their top two or three feet above the surface of the ground.

The condition of the rails as to wear should decide the number of emergency rails to be distributed along the track. Of course, where the rails in the track are badly worn, and broken rails are common, the number of emergency rails should be more numerous than where the track is newly laid, and the rails not much worn.

EXTRA MEN.

27. When you are about to have an extra force of men, larger than you have been used to working, take a little time to plan how you will distribute the men to accomplish the most good. Organization is half the work.

A PROMPT REPLY.

28. Whenever you receive a message from your roadmaster, which requires an answer, don't wait or delay, but answer it *promptly* and correctly.

GET ACQUAINTED WITH YOUR SECTION.

29. Every section foreman, as soon as he has been appointed to take charge of a section, should make himself thoroughly acquainted with

every part of the piece of road in his charge. Get the numbers of all the bridges and culverts on your section, and the distance from the station north, south, east or west. Get the brand of iron or steel and if it is of different makes get the amount of each, and find when it was laid, also the length and kind of iron in your side tracks, number of panels of snow fence on your section, height of bridges from the ground, number of public crossings, signs, etc. Keep this account where it will be handy to refer to at any time, and keep it corrected from time to time. By doing this you will be able to answer any questions asked by officials of the road about any part of your section, and in case of a wreck or washout, you will be able to locate the place at a moments notice, and give a close estimate of the kind and amount of material necessary for repairs, in case of damage to track.

THE PROPER WAY.

30. Find out from your roadmaster the correct way of keeping your time, and filling out any other monthly reports that you have to send in to his office, and make them out as directed by him. You may have a printed form of some kind to fill out. Answer what is asked in the headings on form, but never omit or add anything.

WORKING NEW MEN.

31. If it is necessary to work new men on your section, who have never worked on track before, *do not lose your patience* if they are a little awkward in doing the work. If you can do so, pair these men with older hands. Take a little trouble to show them how you want the work done, in a manner that will give them confidence, and in most cases you will accomplish more good than by using the blow-and-bluster method so common with some foremen. Remember you needed instructions once yourself.

CLEAR WATER PASSAGES.

32. No old vegetable matter, grass, etc., should ever be allowed to accumulate under bridges, or near the mouth of culverts, or any other material that would be liable to catch fire easily, or stop the passage of water.

NEAT STATION GROUNDS.

33. Section foremen should keep the station grounds clean and neat, and all track material should be piled up in several lots. There should be no disorder, *there should be a place for everything, and everything in its place.* All stray links and coupling pins that are fit to use, should

be picked up, and left where they will be handy for train men when wanted. All of the station grounds not occupied by tracks, or covered with ballast, should be allowed to grow up in tame grasses. Such plots should be kept nicely trimmed around the sides and ends, with a view to having them of a regular form, and they should be lined parallel with adjoining tracks. No rubbish of any kind should ever be allowed to accumulate upon tracks, or on the ground close to buildings. It should be taken away and dumped into places which need filling. Section foremen should not spend too much time working around the station, but do what work is required there when other track work is not pressing, or when the weather or extra jobs interfere, and take up so much of the day that it would not pay to go out on the section.

EXPANSION AT SWITCHES.

34. Many section foremen, where stub switches are used, cut the ends off the moving rails, sometimes spending considerable time on a hot day trying to cut the end of a rail off without taking up the rail. Others do a little better and take off the cross rods to cut the rail.

Now, instead of interfering with the moving rails, it is a much better way to cut the next two rails back of them, and control expansion there. It will save lots of time and hard labor on a hot

day, when it is necessary to do such work. Cut off the ends of the rails mentioned from the first bolt hole. This will give a space of about three inches for expansion. Bore a new hole in the rails which were cut, put on the joint fastenings leaving an opening at the head chair joint of not more than half an inch, then loosen the bolts on three or four joints further back, and open them sufficiently to take up all of the space except what is needed in the head chair joint for the rails to move easily. The open joints back of the moving rails can be closed whenever the switch becomes tight, and in most cases the one cutting of rails at a switch will do for a whole season.

LOOK OVER YARD.

35. Yard track foremen should look over the whole yard every morning, and see that all switches are all right, and nothing is wrong, before going to work for the day at some particular place.

LIPS ON STUB SWITCHES.

36. On a road where stub switches are used, a foreman should see that no lips form where the moving and lead rails meet; and that the track lines are true, no matter which way the

switch is turned. To guard against having lips on the rails of stub switches where they meet in the head chair, the head rods on the ends of moving rails should fit *as tight as they can be driven on.* No lost motion should ever be allowed to get in any switch connections. Switch stands should be *bolted* to the head block.

BENT SWITCH RAILS.

37. Brakemen, when in a hurry, often pull the switch lever over before the trucks of the last car of a train are off the moving rails of a switch. This makes a kink or bends the rails out of line, besides, it often forms a lip at the joint in the head chair. The quickest way to fix a pair of moving rails, that have become bent as above stated, is to take out one of the rails and turn it end for end. This makes the bow pull in opposite directions, and in most cases will keep a switch all right until it can be repaired, or new rails put in. When the bend in moving rails is towards the side of track from which switch turns off, drive a stake at the ends of a couple of ties opposite the bent place in the rails, and drive spikes in these ties outside the bend part of rails to keep them in line. This will do temporarily when you have not the time to straighten the rails.

THE MOVING RAILS OF STUB SWITCHES.

38. The moving rails of stub switches should never be cut except when battered. The best method of keeping the moving rails in good condition is to have them of the correct length, and to keep the joints in the head chairs just open enough so that the switch can be thrown easily in warm weather. When the rails begin to contract in cold weather, a pair of extension splices can be put on the connected ends of the moving rails, which will admit of expansion blocks of the proper size being put between the rails to fill up the space left by contraction. Short pieces of splices bolted on the ends of the moving rails, where they come into the head chairs, will assist in making the ends of the rails wear much longer without becoming battered, they should also be on the lead and main track rails where they meet the moving rails on the head chair.

BATTERED SWITCH RAILS.

39. Never take out one rail in a stub switch. When it becomes badly battered on the end, always take out at the same time the rails which meet it in the head chair. A good rail put in, and meeting a battered one, will soon be as bad as the battered one.

TIES UNDER MOVING RAILS.

40. The ties under the moving rails should be oak, sawed ties if possible, and as close together as they can well be tamped. None should be farther apart than 8 inches, and where a switch rod comes the ties should be closed up to within two and a half or three inches of each other. This will keep switch rods in place. The object in having the ties close together under the moving rails is to keep the rails up to surface, and the cross rods square across the track in place; and in case of the trucks of a car or engine getting off the track at a switch, which happens oftener there than at any other place on a railroad, the ties being close together will support the wheels from sinking between them, and car or engine can more easily and quickly be put back on the track without danger of bending the tie rods.

BENT SPLICES.

41 When a foreman receives old iron or steel for repairs he should always examine the splices, especially angle bar splices, and if they are bent in the center he should not use them again without straightening them.

PUNCH OR BORE THE RAILS.

42. When cutting old iron or steel for repairs, always punch or bore holes for two bolts in the cut ends of the rails. Do not put on splices with bolts only in one end, or with less than the full number used in a joint.

LINING DISCONNECTED TRACK.

43. Foremen when lining track that has been washed out, or that has been disconnected at one end, should never commence lining from the disconnected end. Always commence to line track from the end that is connected, and nearest to line, and work towards the end that is disconnected, and when you have moved it once, begin to line as before.

The writer has on several occasions seen foremen with a large gang of men spend several hours of valuable time at a washout, in a fruitless attempt to bring into line the tail end of a piece of track, and when the men could not throw it, cut it into rail lengths and carry it into place. This could have been avoided if track had been lined in the way stated above.

ORDERING TOOLS OR MATERIAL.

44. Track foremen, when ordering tools or material for use on the track in their charge, should *not* make requisition for more than the amount necessary of either kind. A surplus of tools or track material on hand, which there is no prospect of putting in service soon, represents their value in cash lying idle or going to waste.

KEEP MEN'S TIME CORRECTLY.

45. It is a notable fact that the best track foremen keep the time of their men and other accounts correctly, and do everything, as the saying goes, "in ship shape," while the reverse can only be said of foremen who are careless or slovenly. The want of an education is only an excuse, and a foreman, by devoting a little of his time evenings to study, can soon write a good hand, and learn enough of figures to do all that is required of him while in the position of track foreman.

DUPLICATE TIME BOOKS.

46. All track foremen should carry with them a duplicate time book, and note on the same any loss of time, or time earned by any of the men working under them. Keep a journal of the

work performed by them each day, always charging the proper number of days labor done by them at each seperate kind of work. This record of time and work performed should be transferred at the end of each day to the regular time book and journal of work, which is sent to headquarters at the end of each month.

By following above instructions, a foreman will avoid making any mistakes, and will also be able to refer back to the time of his men, the kind of work done, and date of same, whenever called upon for information by his superior officers.

TRACK MATERIAL ACCOUNT.

47. When foremen receive track material of any kind, and it is loaded on cars or unloaded from cars by them, they should check over everything carefully and count the pieces, number of rails, ties, etc.; also note the brand or quality of the same, and take the number of the car. Keep this with your other accounts, no matter whether you have orders to do so or not, as you may be asked to give information on the subject a month later.

PRINTED FORMS.

48. Track foremen should read *and thoroughly understand* the printed instructions on all blank forms which the railroad company requires

them to use, when making their reports. Many foremen are too careless in this matter, often omitting to put down the answers to printed questions which it is almost impossible for them to miss seeing when filling out the form. Occasionly a foreman will put on his work journal the number of ties received during the month, and at the same time fail to give the number of ties used during the month, or the number on hand; while the latter questions are there on the journal, as well as the question, how many ties received. Then the roadmaster must write him a letter a second time and instruct him what he should do and wait for an answer. It is just likely that the foreman spoken of above will be changing a rail in a side track, or doing some other kind of work, which could be put off or delayed without danger, for a week or two, when at that time he should have been examining his track after a heavy storm.

He has carried a time card in his pocket for months perhaps, and never informed himself that there was a rule on that time card which required himself and men to be out and *examine the track on his section in stormy weather.* Foremen of the kind mentioned do not hold a position long under any roadmaster, because they are not reliable, they need to be watched too closely and instructed too often in their duties.

SECTION FOREMAN'S REPORTS.

49. In order to facilitate the making out of weekly or monthly reports, where there are no blank forms furnished for that purpose, foremen should rule a sheet of paper, leaving a space between the lines for each report, with the different headings written at the top of each space; as they would appear on a regular printed form, as shown in the example. This saves stationery for the company, it is simpler and lessens the work of the foremen, because it saves dating, signing, etc., several sheets where one would do; and the roadmaster in turn is benefited, because he is enabled to get through his correspondence much quicker and make up any accounts or estimates to be taken therefrom. All weekly or monthly reports should be condensed into one form when possible, as shown in the example.

EXAMPLE.

WEEKLY REPORT FOR WEEK ENDING JAN . . . . 1888.

DAY OF THE WEEK.	NUMBER OF MEN AT WORK.	HARD TIES PUT IN TRACK.	SOFT TIES PUT IN TRACK.
Sunday.	. . . .	. . . .	. . . .
Monday.	. . . .	. . . .	. . . .
Tuesday.	. . . .	. . . .	. . . .
Wednesday.	. . . .	. . . .	. . . .
Thursday.	. . . .	. . . .	. . . .
Friday.	. . . .	. . . .	. . . .
Saturday.	. . . .	. . . .	. . . .

SHIPPING TRACK TOOLS.

50. Track foremen, when shipping tools or sending them to the repair shops, should always be particular to secure them in a neat package, so that it would not be possible for any of them to become separated or lost while in transit. The name and address of the repair shop foreman should be written plainly on the face of the shipping tag; and on the back of the same tag, the foreman should write his own name and address, together with a request that the tools be returned to him when repaired.

A very convenient arrangement for securing tools together when shipping them, may be made by running a piece of chain through the tools or around them, and locking with a spring key after passing one of the end links through one of the other links of the chain. The key should be flat and just wide enough to fit the links in the manner mentioned. Fine soft wire is superior to twine for securing tools or for tagging them.

DISTANCE TO SET OUT DANGER SIGNALS.

51. Danger signals should be set out a distance of not less than three thousand five hunhred feet in both directions from the point where the track is impassible for trains. This distance can be measured by counting *one hundred and*

seventeen thirty foot rail lengths, in the direction you are going to set out the signals; or when the telegraph poles are one hundred and fifty feet apart, the signals may be set out twenty-three telegraph poles distant each way from the point of danger.

When flagging at obscure places, or in the vicinity of descending grades, where it is difficult to stop a train, the distance to set signals must be doubled or the telegraph operator at the next station should be informed, so trains could be held until track was cleared and safe for their passage. Where there is a sufficient force of men, and it is practicable, the flagmen should remain out with the signals until the track is repaired, or the train is stopped. In all cases during a snow storm, in foggy weather, or at night. *the flagmen must remain out with the signals until all danger is passed.* When the track has been repaired, and made safe for trains, the flags, torpedoes, or other signals should be removed immediately.

ALWAYS KEEP SIGNALS WITH YOU.

52. A track foreman should always keep on his hand car, ready for instant use, a full supply of torpedoes, red flags, or red lanterns, so that if any accident should render the track unsafe for the passage of trains, he would be prepared to protect them promptly. Flagmen sent out to

patrol the track should not be allowed to proceed without having with them all the necessary signals to stop trains. *The foreman should instruct them thoroughly in their duties, as he is responsible for them.*

The first duty of a track foreman when he finds a dangerous place in the track, *no matter whether it is his own section or not*, is to set out stop signals at once; he should then go in the direction from which the next train is expected, and report the trouble at the nearest telegraph office.

TIME CARDS AND RULES.

53. A track foreman should keep well posted on the time of all regular trains passing over his section. He should also study and understand thoroughly all the rules of the company, for which he is working, that relate to his work; and if in doubt about anything, ask an explanation of it from a superior officer. Read over all the rules on the time card at *every time a new card is issued* on your road.

NOTE OF FLAGS.

54. Whenever it is necessary for a foreman to use flags, instruct the man who goes to set the flag out, how to place it. Set slow flag on the engineer's side of train coming towards the place

for which you are flagging; set the flag slightly leaning so that most of it can easily be seen, and set it just far enough from the rail to clear engine and cars. A slow signal should be set out ¼ *of a mile* or about ninety 30 feet rail rengths.

STOP SIGNALS.

55. When a red flag or red light is used as a signal to stop a train, it should be set in the center of the track. Two torpedœs should be used together with the red signal day or night. The torpedœs should be placed sixty feet apart upon the rail, on the same side of the track, between the red signal and the approaching train.

LOOK OUT FOR SIGNALS.

56. Foremen should always look for signals on all passing trains. Another section of the same train which has passed, or a special, may be following close behind; and the track foreman and his men should be fully informed, and keep well posted as to the meaning of all signals displayed on passing trains.

OBSTRUCTING THE TRACK.

57. Track foremen should never attempt to use the track so as to obstruct a regular train.

All work which would make the track unsafe for trains should be finished, and the track ready before a regular train is due from the nearest station in either direction from where you are working.

When working close to a station, foremen should have the track safe and clear at least fifteen minutes before a train is due.

No work, which would make a track unsafe, should be done on the time of a delayed passenger train, except in case of emergency, and then the foreman himself, or a trusty man, should be out in the direction of the expected train, and take every precaution necessary to protect the train by proper signals. Always instruct the man who goes to flag a train in foggy weather, or during a snow storm, that, in case he finds it very difficult to attract the attention of the engineer or fireman on the approaching train, after they have passed his signal, he should, in some other manner, make known to the trainmen the presence of danger, unless an effort has been made to stop the train before it passes him.

REPLACE SIGNALS.

58. Trackmen finding danger signals along the track should leave them in the same position as found, and if the signals are injured so as to be unsafe, they should be replaced by good signals of the same kind, or a man should be left to

guard the point. It is the duty of a track foreman, if he finds danger signals, to go forward and ascertain their cause, and to give assistance with his men, if the train men require their services.

INJURED SIGNALS.

59. All sign signals placed along the track for the guidance of trackmen or others, (when injured or broken) should be repaired at once, and placed in position by the trackmen; and if they are destroyed or renderered useless, the foreman should at once make requisition on the roadmaster for new ones.

COMPLY WITH THE RULES

60. Section foremen or others should use all signals strictly in compliance with the rules of the road governing their use. Never set out a danger signal at a shorter distance than that which is *specified in the rules of the road* as correct, because a serious accident may be the result, if a train cannot be stopped in time.

LOCATION OF WHISTLING POSTS, PAINTED SIGNS, ETC.

61. Station whistling posts should be set one half mile outside the switches, not from the depot, and on the engineer's side, the right hand

side of the track to one approaching the station. Station mile boards should also be set one mile outside the switches, on the same side of the track as the whistling post. These two signs are used to warn the train men of the near approach to a station, that they may be able to get the train fully under control before reaching the station. The yard tracks at all railroad stations extend some distance each way from the depot. It will not do to place the signs above mentioned at the distance stated from the depot, for the reason that in big yards they would often be inside the switches.

Whistling posts for highway crossings should be set one-fourth of a mile from the crossing, on the engineer's side of the track. Whistling posts or signs of any description should never be placed in a cut if it is possible to avoid it. It is always better to increase or diminish the distance to get them out of the cut. The distance should always be increased where there is a down grade, or when the law requires certain signs to be placed a specified number of feet or rods. This rule should also apply on sharp curves. All signs, which have a painted cross board on top of a post, should be set with the cross board at right angles to the track, so that the sign can be plainly seen by the train men for whom it was intended. The cross board on highway crossing signs should be parallel with the track, so that persons approaching the track from either side

on the wagon road can see and read the painted sign.

All posts and signs should be set firmly in the ground, and so far from the track, that if knocked down or blown over, they would not fall upon it. Never set any signs in a leaning or twisted position. Highway crossing signs should be set far enough away from the center of the wagon road, so that wagons loaded with bulky material, such as hay or straw, would not strike the sign post or the cross arm at the top of them.

TRAINS DISRESPECT OF DANGER SIGNALS.

62. Section foremen should report promptly to the roadmaster any failure on the part of train men to honor danger signals set out by himself or his men. If an engineer fails to whistle for brakes, and runs at a high rate of speed past the point for which you have set out a slow flag or if a train runs past a dangerous place before stopping, for which you set out the necessary stop signals, you must report all the facts to the roadmaster without delay, giving the engine and train number, and the time they passed the place where you were working. Foremen should not overlook any neglect of duty by the train men in this matter. Always remember that the safety of trains, and the lives of passengers and employes depends in a great measure upon a strict compliance with the company's rules.

LOOK OUT FOR TRAINS.

63. Section foremen should always keep a sharp lookout for trains while working on track, while using hand cars, or while transferring material from one track to another on cars. Never trust too much in this matter to the men, as they are not held responsible for accidents. To be on the safe side, a foreman should always be expecting a train, then he will be prepared for all extra trains or specials, of which he has no previous notice.

ALWAYS BE PREPARED.

64. Whenever it is necessary for a foreman to go to a wreck or washout, or to assist at any kind of work which calls him away from his own regular work, he should be prepared, havnig lanterns ready to light, tools all on the car, tape line in his pocket, etc. Don't start out half equipped with tools. When you find a place to fix up or repair, and there is need of tools, which you have not with you, you will have to send after them, perhaps delaying trains for an hour or more because of your carelessness. Don't go out on track and discover a broken rail, and at the same time find that everything necessary for repairing it is on hand, except your chisels, and they are in your tool house, seven or eight miles away. A fore-

man who is careless in these matters, is generally so in everything else he does, although he may hold his position for a time. The roadmaster has him marked down as poor material, and will always remove him as soon as he can put a better man in his place.

HAND CAR AND TOOL HOUSES.

65. The hand car and tool houses of track foremen should be kept outside the switches at yards, or wherever is the most convenient place. They should be located so that the men can get to and from work without being delayed by trains standing on the tracks. Tool and hand car houses and track supplies of any kind should always be placed a sufficient distance from the track, so that they will not obstruct the view of the train men, or be likely in case of accident to fall on or near the track.

TELEGRAPH OFFICE REPORT.

66. Where a section foreman's headquarters is located at a station, he should report at the telegraph office for orders and inquire for messages before going out to work every morning, and immediately after working hours in the evening.

REMOVING HAND CARS FROM CROSSINGS.

67. No material of any kind should ever be piled or placed on a highway where it crosses the track. Section foremen or others should never take off their hand or push cars and leave them on the highway or private wagon crossings unless it is absolutely necessary to do so to get out of the way of a passing train. The car should then be immediately put back on the track, and removed to a proper distance from the highway. Section foremen should provide places along their sections, at convenient distances not less than 100 feet from highways or crossings, where they can take off their hand or push cars, and leave them when necessary. Obstructing highways by leaving thereon track material, hand cars, etc., has been the cause of numerous accidents, and claims for damages against railroad companies.

THROWING SWITCHES.

68. Track foremen should not be in the habit of throwing switches for trivial reasons. Although it is the custom on most railroads to allow section foremen to carry a switch key, they should not abuse this right by unlocking and throwing switches to move a hand or push car without a load from one track to another, or to

accommodate train men who should do this work themselves. Hand cars and push cars, even with a light load, can as well be moved from one track to another, where the rails come close together, without throwing the switch. Men employed on the section should not be trusted to throw a switch, except in the presence of the foremen. When a switch has been thrown on a side track, *the person throwing it should not leave it until after throwing the switch back again on the main track and locking it.*

Any foremen who would throw, or allow others to throw a switch from the main track, and leave it in that position while performing a piece of work, or until it suited his convenience to throw it back, should be discharged; and he would be criminally liable if any accident should happen through his carelessness Those intrusted with the operation of switches cannot be to careful.

LEAVING HAND CARS ON TRACK.

69. Some track foremen have a habit of leaving hand or push cars on the track, while cutting weeds or doing other work which requires frequent moving from place to place. This should not be done. The main track should be kept clear at all times, except when track men must occupy it to do necessary repairs; at such times or when moving loads of material on cars, foremen should protect themselves with proper danger signals.

Foremen should not leave hand cars on side tracks as they are liable to be smashed by trains switching, and cause a wreck at the same time.

LOANING TOOLS, CARS, ETC., TO OTHERS.

70. Track foremen should never loan to persons outside of the company's service any tools, hand car, velocipede car, push car, or track material of any kind which is intrusted to their care, without permission of their superior officers. Foremen themselves or their men should not use hand cars, velocipede cars, etc., on the track outside of regular working hours, unless in the company's service, or with permission from the roadmaster.

Foremen who adhere strictly to this rule are very seldom requested by outside parties to grant them any privileges, and thereby save themselves any trouble or annoyance. Track foremen should also remember that company material of any kind, no matter how valueless it may appear to them, *is still the company's property*; and that they have no right to appropriate it for their own use, or to sell it to others, without authority from their superior officers.

DIFFERENT VARIETIES OF TIES.

71. On a railroad where different varieties of

ties are used in the track, the softer kinds of wood should be used in straight track, and the hard wood ties should be used in the curves, and in sags between heavy grades where the speed of trains is very fast. If hard wood ties can be procured for a curve track they should not be mixed with soft wood ties in the same track, because the rails will in the course of time cut a bed in the soft wood ties, and thereby affect the surface of the track. At the end of bridges and under switches are also good places to use hard wood ties, where they can be furnished for that purpose. White cedar is the best soft wood tie, white oak the best hard wood tie.

CARE OF TOOLS.

72. The following instructions in regard to the proper care and handling of shovels, claw bars, cold chisels, etc., are only given to bring to the notice of track foremen the necessity of looking after all of their tools, either in or out of service, and to see that they are not needlessly damaged or destroyed. Careless workmen are liable to injure track tools in numerous ways not mentioned in these pages, but which an intelligent foreman can see in time and prevent.

HAND CARS, ETC.

73. Hand cars, push cars, and velocipedes,

should be oiled regularly, the axle and other boxes kept tight, and care should be taken to have them ready for service at any time when needed. A good, light, easy running hand car saves labor, and foremen should not injure their hand cars by hauling loads of rails on them. It may sometimes be necessary to take one or two rails on a hand car to save time, in case of a broken rail or wreck. In such a case, balance the rail lengthway on the car, and keep it as close as possible to the side of the car.

SHOVELS.

74. Shovels, more than all other track tools used on a railroad, figure as a large item in the expense of general track repair. Track foremen should be very particular to instruct their men not to hold up the ends of ties with a shovel,nor to space ties in track with it, nor to stick the corners of a shovel blade in a tie to pull it under the rails, etc., and, in fact, not to use the shovels in any way that will strain or break them. The greater number of the old shovels which are thrown away as useless, could have been made to do good service a much longer time if handled properly.

COLD CHISELS.

75. Cold chisels, when first dressed by the blacksmith, are not always of a good temper at the point. Track foremen should handle a cold chisel carefully when cutting the first rail with it. If it gets slightly blunted at the point, or a chip comes off from it, put it on the grind stone and grind it true, after which a chisel, which was hard before the grinding, will often cut a large numberof rails before it is necessary to send it to the shop again.

USE OF CLAW BARS.

76. Claw bars should not be used between the bottom of the rails and track ties to spring up the rails or raise track. Using claw bars the above way, especially in frosty weather, frequently breaks off the claws on the end used for pulling spikes. Such breaks are difficult to repair, and if that end of the bar is a combination of iron and steel it is likely that enough of the steel will break off to render the bar useless.

LINING BARS.

77. Lining bars should be made as light as possible; just so strong that one man can not either bend or break a bar when pulling

track to line. Foremen should not allow the men to use the small end of a lining bar in the ground when pulling track; and when not using them the men should stand up all bars with one end in the ground in hot weather, or keep them in the shade. This keeps the bars cool so that men can comfortably handle them; it also does away with the necessity of hunting through the grass for bars, when they are wanted to use or to take home.

RAIL PUNCHES.

78. If rail punches are used to make bolt holes in a rail, the work can be done quicker and as well with the punch alone, as with the aid of the cold chisel. If it is possible, always punch the bolt holes in a rail before cutting it, as old rails which are cut first, and punched afterwards, are liable to split under the ball of the rail. When a rail drill can be procured to bore the holes in a rail, never use a rail punch, and bore all the holes necessary to full bolt the joint.

THE PLACE FOR TOOLS.

79. Foremen should bring home every night and put in the tool house all tools which they have been using on track during the day. Never leave tools out on the section. Unscrupulous persons who live near the track or who may pass

along there are very apt to appropriate any tools which they find along the track. Any loss of track tools should be reported by foremen to the roadmaster.

CUTTING STEEL.

80. Whenever it is necessary to cut steel rails, track foremen should instruct the men how to do it properly. All steel or iron rails should be cut as accurately as possible as to length, and allowance for expansion should be deducted from the length of the rail. No careless work should ever be allowed, such as cutting the rail one inch or more short of the proper length.

The line of the chisel cut around the rail should be continuous and square across the rail. Iron rails, as a general rule, need to be cut deeper than steel before they will break off. Hard steel, if cut deep, is liable to become tough at the cut, and will sometimes break off on either side of the cut, leaving a bad unshapely end on the rail. To break off a rail at the cut, lift up the rail at the end nearest to the cut, and let the cut place fall over a piece of rail laid on a tie, or something solid laid across the track rails. Short pieces to be cut from rails may be broken off with the sledge. When cutting rails or punching them, trackmen should not use a spike maul to strike the chisel or punch, because this destroys the face of the spike maul, and splits

pieces from the head of steel tools, making them worthless in a short time. A good sledge made on purpose for striking hard steel tools should be one of the tools on every section, and should be taken in preference to any other tool of the kind whenever necessity requires its use.

THE BALLAST IN YARDS.

81. The yard track at all stations inside the switches should be dressed off level with the top of the ties, both inside and outside of the track rails. When there is enough ballast the shoulder should be level and of a sufficient width to allow train men or passengers room to walk along outside the ties. Where yard tracks are close together no rubbish, or obstructions of any kind, should be placed on the space between them, or allowed to remain there.

EXECUTE PROMPTLY.

82. When the foreman receives an order from the road master to do any special piece of work, he should do it at once, and finish it up in the manner in which he is instructed. It is of the greatest importance that track foremen adhere strictly to this rule. Nevcr let work wait to suit your convenience, nor do any work in a way contrary to that in which you are ordered to do it.

PROTECT AGAINST FIRES.

83. In the fall of the year when the weeds and grass along the right of way have become dead and dry, section foremen should take every precaution to protect the compony's property, and that of persons living near the track, from damage by fire. Fire started by sparks from locomotives, or from other unknown sources should be looked after at once and extinguished. Do not cease your efforts until you are sure all danger is past. All wooden structures, bridges, culverts, etc., should be examined as often as you pass them and any combustible matter which may be close to the timbers should be removed. Be particular, when burning rubbish or grass along the right of way, to always work with a favorable wind. Run no risks, and if you see a doubtful smoke along the track, take your men, go to it at once, and find out what has caused it.

THE CURVING HOOK.

84. Where curving machines are not furnished, the curving hook is a very handy tool, and there should be one kept on every section. With it and a track level, a foreman can straighten rails or curve them, and also remove a surface bend from a rail weighing less than 65 pounds per yard.

The following is the manner of using it:

Place two ties across the track nearly a rail apart, lay the rail upon the two ties, attach your curving hook to the track rail between two of the track ties, place the end of the lever in the curving hook, and press it down on the rail to be curved or straightened. A third tie or block is used to put under the rail to be curved, when the bend is short. The tie on either end is moved up closer to take out a kink without affecting the balance of the rail. To remove a surface bend from a rail, the rail should be placed work way on the top of the ties above mentioned, and under the lever, just as when a rail is being curved.

REPORT STOCK KILLED.

85. All stock killed or injured, and found lying on the right of way by section foremen, should be reported promptly to the roadmaster. Section foremen should always report the stock killed or injured, whether they were struck by a passing train or died from natural causes. It is the duty of foremen to make an examination of the body of the animal found, find the owner if possible, and get the age and cash value of the animal. If it was struck by a train, give engine number, train number and time of the accident, if you know it. In your report give all other information which is likely to be of any value to

the company you are working for. If the owner of a dead animal does not remove it from the right of way, the section foreman should take his men and bury the carcass after investigating the cause of accident, etc.,

Foremen have no right to appropriate to their own use (or to allow others to do so) the carcass or hide of any animal killed along the track.

DAMAGE BY FIRE.

86. When property along the right of way has been destroyed or damaged by fire, the section foreman should go to such place at once, examine the ground thoroughly, measure the distance from the centre of the track to where the fire started, find the value of the property destroyed, make out an itemized estimate in his report; and also state the direction of the wind when the fire was burning, and give a true account of every thing as far as he knows. Do not accept the statement of others until you know them to be correct.

BE CAREFUL OF MATERIAL.

87. When a track foreman lays or extends a piece of track, as soon as he has finished the job he should have every loose spike, bolt splice, etc., picked up and taken care of. Track ma-

terial lying around where a gang of men have been working, is very good evidence that the foreman is careless about his work and wasteful of the company's property. If loose bolts or spikes were picked up and taken care of until used, many thousands of dollars would be saved for the company in a year.

PICK UP SCATTERED MATERIAL.

88. Never allow old iron taken out of track, old ties, broken brakes, links, pins, etc., to accumulate on your section. Bring them into the station and ship to the points designated by the roadmaster, all except what is needed for use on your section.

DO FIRST WHAT NEEDS TO BE DONE.

89. A track foreman should always have his work planned ahead. By giving close attention to the track, as he passes over it daily each way, a foreman will always be able to see what needs to be repaired most, and it is hardly necessary to say here that such work should be done at once. Do not ride over the same low joint every day, a joint half an inch out of gauge or line, or pass the same broken joint tie or bolt hanging loose in the splices expecting to fix such places the next week or waiting until the roadmaster calls your attention to these things. The longer

you wait, the more these little odd jobs increase in number, and at about the time you have set to do them you are called off to some place else. The work still increases during your absence, and in this manner things go on the year round. You are always behind, always worried; you think the roadmaster hard because he urges you to hurry; you make excuses for yourself, as for instance, that you were putting up a nice piece of track some where else on the section. But always remember that if you had ten miles of the best track in the country, all good track except one rail length, and that rail was dangerous, the balance of your section, no matter how good, would not save a train from getting wrecked, nor you from the blame that would justly fall upon you. In no other line of business does the old saying apply with greater force than on a railroad. "Never put off till tomorrow what should be done to day."

HOW TO DO WORK.

90. Experience will teach a foreman that the secret of keeping a good track on his section lies in doing all work well. Slight no work. Do not surface up track to make a big show for the present, but surface it as fast as it can be done to make track that will remain good a long time. Very smooth track, well lined and gauged, will stay good some times for years without much re-

pairing. On the other hand, track that might be called good, with an occasional slight dip in the surface, if there is much traffic over it, will soon be bad track; because, where quarters or joints are only one quarter of an inch low after the track is surfaced, the weight of an engine or loaded cars strike such low places with great force, and gradually increase the depression until the track becomes very rough and dangerous. If not cared for, low places in track knock out of gauge and line besides getting low. The same method of doing work will not answer always. Foremen should adopt a method of doing work that will give the best results with the kind of material furnished.

If you have only dirt for ballast, don't always be telling what good track you could have with gravel or rock, but see how good a track you can make with dirt for a ballast.

FOREMEN ON DUTY.

91. When on duty, the foreman should always be with his men and assist them in doing the work. It is his duty also to instruct his men by word and example as to the proper manner of performing all the different kinds of work in which they are together engaged.

ADOPT THE BEST METHOD.

92. If you can improve on the old method of doing any kind of work, when you are not satisfied with the results of a trial, adopt a new plan. When you do any kind of work on track, and it does not give satisfaction, always try to find the remedy for its defects. Do not say it can't be done, but remember that a man who finds himself in a difficult position, if he has good judgment and a lively brain, can work out some of the most difficult problems without any previous knowledge of them. Never take a slow method to do any kind of work that you can do as well in a quicker way. Don't forget that the world moves, but move with it. Try to learn something from the experience of others who are successful in the same profession as yours. A trifle of time gained soon amounts to a day, month, or a year, if multiplied many times. Take for example two men spiking track, one strikes across the rail when his partner tacks the spike in the tie, then both finish driving their own spikes. Another man tacks his spike, and does all the driving on it himself without striking across the rail. On every spike he drives, the first man gains two motions which the second man loses, and at the end of a hard day's work the first spiker will be a long distance ahead of the second man, and with considerably less labor; although to the inexperienced onlooker there

would be no perceptible difference in their methods of working.

Take for another instance the case of two foremen putting new ties in the track. One removes all the dirt or ballast from the center of the track to the outside of the rails in order to get a number of ties into track at once; the other foreman moves the material in the center of track back upon the new ties as fast as he puts in two or three; and by method the latter foreman *saves* himself and his men the labor of shoveling many yards of ballast from outside the track rails to fill the center of the track. To bring a section of track up to anything like perfection, the foreman in charge of it must look closely after all the work in its minutest details, and allow nothing to go undone which would contribute towards improving the track. None but careless foremen will line up one side of a track well and then leave it without taking the kinks out of the gauge side at the same time. A careless foreman will put a new tie into track without taking up to surface a low joint close to it. He will cut weeds past a joint with a bolt broken out of it without putting in a new bolt. He will make a trip over the section, and never notice a break in a fence, or if he does note it will wait to be notified by the roadmaster to fix it. It is likely that you will find the same foreman surfacing a piece of track without using a spirit level on it. Such a man is not fit to make

a good laborer much less a foreman; and the piece of road in his charge will soon run down if he be not discharged, and replaced by a foreman who has a desire to improve the track whenever he does work on it. The work of a careless foreman puts the roadmaster to watching him, because he informs on himself every day; while the careful, industrious foreman makes a good, permanent job wherever he works, and the result is a first-class track where recently may have been a very rough section.

WRECKING.

CHAPTER IX.

WRECKING.

1. The first duty of a track foreman, when he receives notice that there has been an accident, and he is wanted there, is to collect his men and take his hand car, and all his portable tools, even those which he thinks he is not likely to use. He should not go short of tools expecting that the other foremen there will have enough. The other foremen may think the same, and valuable time will be lost by the want of forethought of both.

ON THE GROUND.

2. When a track foreman arrives at the scene of the accident, he should proceed immediately to do whatever work, in his judgment, would contribute most to putting the track in a passable condition for other trains, notwithstanding the absence of his superior officers, who may not be able to reach the wreck for several hours. If the track is torn up, and the cars do not interfere, put in ties enough to carry a train safely over where you can. If the rails are bent out of shape secure some from near by, if it is possible. If this cannot be done, get as many as possible of the damaged rails to their proper shape, and spiked down in the track.

If a small bridge or culvert has given away, crib it up with ties until you can cross it with track. If you cannot procure the ties along your section, and many are not needed, remove a part of the ties from the track where it is full tied, and where it will leave a sufficient number in the track to make it safe for the passages of trains.

In the same manner, if you are short of bolts and spikes and too much time would be lost by going after them, borrow some from track where they can be spared and fix track to let trains pass.

TO SQUARE A CAR TRUCK.

3. If one or both trucks beneath a car should leave the track at once and turn across it as is often the case, uncouple from car and hitch a switch rope to the corner of the truck and to the draw head of the car next to the one which is off the track. Then pull the truck into a position parallel to the track, after which it can be put on the rails with the wrecking frogs.

If the car should be loaded very heavily, it might be advisable to raise the end with jacks before squaring the truck. If the right man undertakes this job, the train need not be delayed over thirty minutes.

WHEN A CENTER PIN CANNOT BE USED.

4. Sometimes when a car leaves the track, the center pin breaks, or is so badly bent that it cannot be used again. This often happens on the road when there is nothing at hand to remove the crooked pin. In such a case, if the car is empty, or not heavily loaded, it is best to roll the truck from beneath the car off the track, and haul the car into the station carefully supported on that end by the regular coupling pin and link.

When the ends of a broken center pin do not project, the end of a car can be jacked up, the truck placed in position, and the end of the car

again allowed to rest in its place on the truck, after which, if watched carefully, the car can be hauled a long distance.

WITHOUT AN ENGINE.

5. It often happens that a car gets off the track in such a place that it is impossible to get the help of an engine to pull it on again without considerable delay. When a case of this kind occurs, and there are other cars on the track near by, take the car nearest to the one off the track, and couple the two together with a chain, or a rope long enough to give plenty of slack. Then get together what men are available, and push the car which is on the track close to the wrecked car. When you are ready to pull the wrecked car up on the track, start the car which is coupled to it away from it as fast as the men can push it. The jerk, when the slack of the line is taken up, will pull the car on the track as well as an engine can do it. If you have men enough, use for the motive power two or more cars, if necessary. This is what is called "slacking a car onto track."

CARS OFF ON TIES.

6. When cars have got off the track, and are still on the ties, it is best to put blocks or ties between those in the track to keep the

wheels from sinking between the ties. By doing this at once, before attempting to put the cars back on the track, will generally save considerable time and labor.

OIL THE RAIL.

7. If an engine or car mounts the outside rail of a sharp curve, and persist in running off the track, oil the rails thoroughly where the most trouble is experienced. This will generally allow the engine or car to go around the curve without leaving the track.

Very rusty rails on a curve track, which has not been used for some time, often causes the wheel to mount the outside rail of a curve, the surface not being smooth enough to allow the wheels to slide.

BROKEN SWITCHES.

8. If at any time, you find the connecting rod of a stub switch broken, or you want to use the switch and have no switch stand, slip a car link between the ends of the lead rails, allowing enough of it to project to hold the ends of the moving rails in place, or take a piece of plank of the right shape, and use it in the same way as the link. This is better.

CAR TRUCKS IN THE DITCH.

9. When the car trucks are thrown some distance from the track in a wreck, the quickest method of putting them on the track again, if you have no derrick car, is to take bars and turn them almost parallel to the track, but with one end a little the closest to the track. Hitch a rope to this end of the truck, and to the engine, or the nearest car which is coupled to the engine, and the truck will pull onto the track easily, if there is nothing to obstruct its passage.

TO CONNECT BROKEN CHAINS.

10. A link made of iron or steel, and fashioned after the pattern shown in Fig. 28, is very handy to have when at a wreck, pulling cars or engines with a chain. If a chain breaks the two broken ends can be brought together, and fixed in this link as if held with a grab hook.

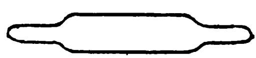

Fig. 28.

TO TURN A CAR ON SOFT GROUND.

11. When car trucks are sunk in soft ground at a wreck, and there is no derrick car or other

lifting apparatus at hand, a good way to handle them is to place a tie cross way in the ground, about four or five feet from the truck, then place two more long ties or timbers, with their centers resting across the first tie, and their ends in front of the truck wheels. The truck can then be pushed up on top of the long ties as if on a track. When it is centered over the bottom tie, the truck can be easily turned to run in any direction.

TO PUT A WRECKED GRAVEL PLOW BACK ON CARS.

12. Trackmen in charge of a ballasting outfit if they are new in the business, are often at a loss to know the quickest way to put a plow back on the cars, if it should accidentally be pulled off on the ground. The best way to do in such a case is to roll the plow or pull it with the engine and cable into the same position on the track that it would occupy on the cars; then raise up the snout of the plow until you can back the end of a car under it, hook the end of the cable to the plow, block the car wheels and pull the plow on to the car with the engine.

SLIDING A CAR ON A TIE.

13. If the hind truck of any kind of a car should by accident be derailed, broken or rendered useless, the car could be taken to the next

station by uncoupling it from the cars be hind it. Remove the disabled truck from the track; then take the caboose jacks and raise the body of the car enough to slip a tie under it across the track rails; let the car down upon the tie, and by running carefully the car can be hauled to the station or side track, sliding on the tie.

LOADED WRECKED CARS.

14. It is always best, when a wrecked car is loaded, to remove the load, or transfer it to another car on the good track. Outfits starting to go to a wreck should provide themselves with all the tools and appliances necessary for this purpose.

BROKEN CENTER-PINS.

15. Car-truck center-pins, which have been twisted or broken in a wreck, may be removed by going inside the car, and cutting away with a hammer and cold chisel the iron ring which forms the head and shoulder of the pin. The pin may then be driven down through the bottom of the car.

There should always be a man on hand at a wreck to look after such jobs, and promptly remove all broken break-beams, hanging irons, etc., so as not to delay the work after the cars

are picked up, or ready to be put upon the track.

PULLING ON A CHAIN OR ROPE.

16. When pulling on a chain or rope with a locomotive at a wreck, care should be taken not to have too much slack, as chains break easily. The same is true of switch ropes, but when they are new or not much worn, they will stand a greater slack strain than a chain will. Wire cables are preferable to either a chain or a rope, for pulling, and they will stand a much greater slack strain, if not allowed to become twisted out of shape.

There is always danger of chains or switch ropes breaking when engines are pulling on them at a wreck, and those working near should not be allowed to stand too close to them.

A DEAD MAN.

17. What is generally termed "a dead man" is a device sometimes used to anchor a guy or stay rope, where wrecking cars, engines or derricks have to do very heavy hoisting or pulling. It is made by digging a trench five or six feet deep, at a proper distance from the track and parallel to it. A narrow cross trench is then dug, slanting upward from the bottom and middle of the first trench, to the surface of the

ground. A good track tie or heavy timber is then buried in the first trench, and the rope is passed down through the cross trench and secured to the timber.

WRECKED ENGINES.

18. The first thing to do with a wrecked engine, if the frame is good, is to take jacks and put the engine in an upright position, such as it would occupy if standing on the main track. It may then be blocked up and raised sufficiently to place under it rails and ties, forming a temporary track. The main track should then be cut at a rail joint, and lined out in an easy curve until the ends of the rails are in line with the temporary track. The tracks should then be connected and the engine pulled upon the main track. If the engine stands at such an angle as to require a very sharp curve in the track over which it is pulled, put plenty of oil on the track rails, and elevate the outside rail of the curve.

If the engine is only off the rails, and still on the track ties, additional rails may be spiked down to the ties in front of the wheels like a switch lead, and connected with a pair of the track rails. The engine may be pulled on again over this lead and the main track closed. This method is quicker and better, for putting a derailed engine on the track when more than one truck is off the rails, than using frogs or blocking.

HOW TO WORK AT A WRECK.

19. The first thing to do at any wreck of importance, where cars block the main track, is to use the first locomotive which can be put into service, and with switch ropes pull clear of the tracks all cars, trucks, or other wreckage which cannot be readily put back on the track with the facilities at hand for doing such work. Proper care should be taken, in doing this part of the work, not to injure freight in the cars. When necessary, remove it from the wrecked cars to a place of safety, and pull the cars and trucks into a position alongside the track, where it will be handy for the wrecking car to pick them up after it arrives.

The moment the track is clear of wreckage, the track force should go to work and repair it, and quickly put it in good condition for trains.

Track foremen should not allow their men to become confused or mixed up with the other gangs of men which are present at a wreck, except when it is necessary for more than one gang of men to work together; even then the foreman should keep his own men as much together as possible, so as to always be able to control their actions and work them to the best advantage.

No matter what part of the work at a wreck a foreman is called upon to do, he should act promptly, and work with a will to get the wreck cleared up, and the track ready for the passage of trains with as little delay as possible.

MISCELLANEOUS--TABLES.

CHAPTER X.

1, WORK TRAIN SERVICE—2, To whom responsible—3, Track inspection—4, Standards adopted by the Roadmaster's Association of America—5, Standard rails—6, Standard track joints—7, Nut locks, track bolts and spikes—8, Longer rails—9, Premiums for track men—10, Hints to section foremen—11, Train yourself—12, Section record---13, Average day's work for one man.

14, TABLES—TRACK BOLTS—15, Spikes—16, Number of spikes—17, Tons of rails required for one mile of track, Table—18, Number of cross ties required for each mile of track—19, Length of rail and number of joints, splices and bolts for each mile of track—20, Weight per yard, per 30 foot rail and tons per mile, Table—21, Lumber table—22, Cubic measure—23, Square measure—24, Surveyors measure—25, Long measure—26, Speed table for trains—27, Table of wages on a basis of 10 hours per day—28, Table of wages one cent to $2.00 for any part of 30 days.

WORK TRAIN SERVICE.

1. Trackmen who are in charge of work train gangs should make it their business to keep the men employed whenever the train is delayed in the regular work. There is always plenty of work along the track at any point. A good fore-

man will have his work laid out ahead, so that there will not be any delays, except those which are unavoidable.

When possible, it is always best to put a good practical workman in charge of a gang of men on a work train. It is poor economy to have an inexperienced train man in charge of a work train and a large crew of men (as is often the case.) When the position of foreman over the men and conductor of the work train is held by one person, the preference should be given to a trackman if competent to run the train, or to a man who has had some experience in both branches of the service.

TO WHOM RESPONSIBLE.

2. Work train conductors and foremen of gravel pits, or of steam shovel outfits, should receive their working orders from, and be strictly responsible to the roadmaster, on whatever division of the road they are working at the time. Work train conductors should report daily to the roadmaster on blank forms furnished for that purpose, and, if required, they should also report to the division superintendent. They should also make a lay up report to the train dispatcher every evening after quitting for the day, and inform him where the train will work the following day.

Work trains should always lay up over night at a telegraph station.

Conductors of work trains should see that the axle boxes of all the cars in their trains are properly packed, and oiled as often as necessary, and that all defects in rolling stock or track, where the train is working, are repaired. All accidents to cars, and anything which would interfere with or delay the work should be reported promptly to the roadmaster or superintendent, so that they may be quickly remedied.

TRACK INSPECTION.

3. There should be a well organized system of track inspection in force on every railroad, and it should be made efficient in proportion to the amount of traffic and the condition of the track.

On roads where only 10 trains a day or less pass over track, an arragement could be made to have the section foreman, on days on which his work would not call him to the end of his section, send a man over to examine the track from whatever point the gang were working and whenever there would be economy in it, the hand car could be run to the end of the section in preference to sending a man over on foot.

The writer does not believe it is good policy to force the section foreman to go over all his track daily, on long sections during the summer months when there is but few trains and plenty

of work for him to do with a small crew of men. But in case of storms all track should be examined day or night.

When a railroad is double tracked, or there is a large number of trains daily over a single track, a regular track-walker should be employed, whose business would be to go over the whole section once a day in each direction, and to be required to report to the section foreman, and also to the station agent or operator, when there is a depot at both ends of section.

The track walker should so time his passage over the section as to be able to see all of the track or at least the most dangerous points, a short time ahead of passenger trains, and when most of the trains run at night, his examination of track should be made altogether at night, the section crew or another track walker looking after it in the daytime.

During the winter months, when the ground is frozen solid a rule obligating the section foreman to see all of his section daily, should be strictly enforced because at that time of year the danger of accidents is greater, and the amount of general track work that can be done is much less than at other seasons of the year.

During extremely cold or stormy weather is just the time that track most needs to be examined, and in order to insure inspection of track at least once a day, I would recommend that, when it is not possible to run a hand car, the

section foreman with one of his men be allowed to ride one way on trains, against the storm to the next station or to the end of his section and return back over the track on foot carrying what signals and tools would be necessary in case of an emergency.

The conditions are so varied on different railroads and sometimes on small divisions of a railroad that the writer believes each company can best organize a system of track inspection which in the judgment of its officers would be best suited to its wants. The foregoing methods are only offered as suggestions from which something more useful might be designed.

STANDARDS ADOPTED BY THE ROADMASTERS ASSOCIATION OF AMERICA.

4. Believing it to be a matter of the greatest importance that track men generally be as fully informed as possible on all subjects connected with their duties and especially the opinions advanced or methods advocated by intelligent members of the profession for the betterment or improvement of the track service. I have devoted space in the following pages to a few of the most important standards recommended at the different conventions of the Road Masters Association of America.

STANDARD RAILS.

5. On Thursday afternoon, October 11th, 1887, the Road Masters Association of America in convention assembled at Cobumbus, Ohio, discussed the subject of "Standard Rails." Following is the committees report which was accepted:

To the President and Members of the Roadmaster's Association of America.

Your committee appointed to make a report upon the weight, form and mechanical construction of railroad rails submit the following:

1. Weight of rail—While it seems desirable for the increased weight of engines and tonnage of cars, plus their additional weight, together with the increase of speed, to use more metal in the rail, thereby allowing a greater degree of hardness, in as much as this subject is at present receiving considerable attention in railway circles as well as with the manufacturers of steel rails, your committee are not prepared to say (in consideration of the quality of rails now manufactured,) what its weight should be. However, we take pleasure in submitting for your consideration drawings and blue prints of rail sections, weight from 60 to 100 pounds per yard.

2 Form of rail—Your committee recommend No. 4, 5 and 6 of the accompanying blue prints. Your committee further recommend that this association urge the importance of a standard section for all weights, yet we fear the time has passed, if it ever existed, to bring engineers and manufacturers to unite upon a standard section.

3. Mechanical construction—This opens a volume of which we will touch but little. 1. All the metal necessary to admit of hardening properties sufficient to resist the traffic. 2. Perfect rolls and well finished in line and surface. 3. Rail to be as high as possible without sacrificing other proportions. Base equal to its height. It goes without saying that the proper distribution of metal gives the greatest strength and durability.

ISAAC BURNETT,
R. A. WILLIS,
T. RAFFERTX,
O. S. JORDAN,
Committee.

The discussion of the report of the committee on the subject of "Standard Rails" was continued by the convention into the next day's session. Then Mr. F eed, of the S. F. & W. Ry. offered the following substitute to the report of the committee.

"It is our experience that with first class steel rail on our main trunk lines where the interchange of traffic necessitates the passage of a heavy tonnage and heavy locomotives at rapid rates of speed on well ballasted and well tied roads, *nothing less than a 60-pound rail* is sufficient for the maintenance of a first-class track. On unballasted roads the weight of rail should be increased about 15 per cent. to make up for the absence of ballast, and on roads of lesser tonnage a rail of less weight to suit each special case, as determined by competent engineers and roadmasters, should be adopted."

"A section of the usual T pattern, made with a sufficient quantity of metal in the head to best resist wear, and so formed as to give the greatest

strength and economy of metal and the greatest bearing surface for both tread and flange, is in our judgment the best."

"The rail should be perfectly straight, without mechanical flaws. It should contain as high a percentage of hardeners as possible to give toughness, and, at the same time, avoiding too great brittleness; these qualities to be determined both by appropriate chemical and mechanical tests and by careful inspection.

The above substitutes were accepted by the committee and adopted unanimously by the convention.

STANDARD TRACK JOINTS.

6. On Wednesday, September 12, 1888, the Roadmasters' convention held at Washington, D. C., discussed the subject of standard track joints. Following is the majority committee's report as presented and accepted:

The undersigned, a majority of the Committee on Standard Track Joints, beg leave to submit the following report: That the best device now known to them for a standard joint is the angle bar. That this angle bar should be from 42 to 44 inches in length, with slots for spikes 2 and 6 inches from the ends, with six bolt holes, spaced from 6 to 7 inches apart, resting on three ties, 9x7 inches and 8 inches apart, weight 60 pounds per pair for a 60-pound rail, and increased proportionately for increased weight of rail shaped to conform to the head and flange of the rail, allowing about 3-16 inch space between the

splice and the web of the rail, to permit of tightening. The cross section of joint shown by figure 6, page 28, of annual report for 1887, meets our views as to shape and fit. The bolt holes in both plates should be oblong in form, and round or button head bolts, elongated under the head to fit the oblong hole in the plate should be used. For rails weighing from 60 to 70 pounds per yard, a splice bolt $\frac{3}{4}$ of an inch in diameter with a square nut of the proper size should be used when practicable; and for rails weighing over 70 pounds per yard a bolt $\frac{7}{8}$ of an inch in diameter of the same form should be used, and a metal washer or spring should be used between the nut and the plate. As far as we now know we are in favor of giving the angle bar, made heavy in the center and tapered towards the ends, a more extended trial before deciding on its merits over one of a uniform thickness throughout. That we decidedly prefer a supported joint to what is generally known as a suspended joint.

P. Nolan,
A. B. Adams,
T. Hickey.

After the subject of Standard Track Joints had been discussed for some time, and it being necessary to proceed with other important questions before the close of the session. Mr. Ellis, of the P. & W. Ry. offered the following resolution which was carried unanimously.

Resolved, That both the minority and majority reports of the "Committee on Standard Track Joints" be recommitted to the committee to report at the next meeting, with the request to members who are so situated as to be able to experiment with the two-tie, suspended, heavy

angle bar, and the three-tie supported angle bar as a joint, placing the same not only on the new steel rail being laid, but upon steel rail that has been in use and that is somewhat crippled by use. To report to the committee the practical results of such experiments.

At the Denver convention of the Road Masters Association of America, held Sept. 10th, 1889, the subject of "Standard Track Joints" was again discussed and the committee reported in favor of the details presented by the "Majority" report at the Washington meeting, with an amendment recommending the use of a plate of iron or steel laid on the ties under the base of the rails to be used in conjunction with the angle bar.

But in the discussion which followed it became evident that but few of the members favored the use of a base plate and McCourtney of the L. S. & M. S. Ry. offered the following amendment.

Resolved, That the long angle bar resting upon three ties—one tie to be placed under the center—makes the best joint known. The angle bar is to be of sufficient weight to resist the strains under all circumstances. Their length should be from thirty-six to forty-eight inches, being governed by the number of ties used per mile, making the ties the same distance from center to center that they may be under any part of the rail. The angle bar is to be fastened with four or six bolts and slotted for spikes at each end. They should be made of a good quality of steel.

This amendment was accepted by the president and voted upon and carried by a two thirds

vote of the members present.

NUT LOCKS, TRACK BOLTS AND SPIKES.

7. At the afternoon session of the first days proceedings, the eighth Annnual Convention of the Roadmasters' Association of America, held at Detroit, September, 9, 10, 11, 1890. The committee on nut locks, track bolts and spikes, presented the following report:

To the President and Members Roadmasters' Association of America:

GENTLEMEN—Your Committee appointed to consider and report on the subject of nut locks, track bolts and spikes respectfully report, recommending that railroad officials should exact, and manufacturers should give greater attention to the production of track fastenings, superior both in material and workmanship. The great tendency is to cheapen the product at the expense of its quality, and this your committee deem it wise to protest against. With reference to nut locks, there are two general classes—positive and elastic. Your Committee does not consider it proper to suggest any particular manufacture or design, but recommend the following general specifications:

For general main line use, and elastic steel nut lock washer, made with sufficient resistance to require a pressure of at least 3,000 pounds to compress it; the total possible compression not to exceed $\frac{3}{8}$ of an inch. For frogs and crossings, an elastic washer with a resistance of 6,000 pounds, or a positive nut lock may be used. The elastic

washer should present a total bearing surface—upon each nut and the plate—of at least $\frac{3}{4}$ of a square inch; and it would be better if that surface could be increased to at least 1 square inch.

A washer of this character should be used with every bolt, and should be compressed by the nut, not to exceed 80 per cent. of its possible compression.

With reference to track bolts we would recommend the following diameters: For rail from 50 to 60 pounds per yard, $\frac{3}{4}$-inch; from 60 to 80 pounds, $\frac{7}{8}$-inch; above 80 pounds, 1-inch, and 1-inch bolts should be used with all frogs. The material of all bolts and nuts should be steel. In length bolts should not extend "more than $\frac{1}{4}$" from nut when the latter has been screwed up properly. Threads should be of standard pattern, and both nuts and bolts should be threaded so as to produce, as nearly as possible, a uniform and close contact between the planes of the threads. Heads of bolts should be round, with an oblong shoulder next to head to prevent turning. The nut should be of hexagonal pattern, the thickness of nut, and the width of each hexagonal face, should be the same as diameter of bolt.

With reference to spikes we would recommend steel as the best material. Pattern the same as now in general use, and size $5\frac{1}{2}$ inches long under the head by 9-16-inch diameter. The points should be neatly finished—of such a shape as to admit of driving without turning from the rail, and to avoid seriously injuring the fibre of the wood.

We recommend steel spikes because we believe that such material, properly tempered, will wear far better than iron at that part which comes in contact with the rail, and. also, because we be-

lieve a steel spike stronger than an iron one of the same dimensions.

G. W. BISHOP,
M. PHILBIM,
J. M. MEADE,
H. W. REED,
J. KINDELAN.

The above report was accepted and discussed and after being read a second time on a motion made by president Creig. It was adopted unanimously by the convention.

LONGER RAILS.

8. Why should the length of a track rail be only 30 feet if it can be demonstrated that there is economy in using a rail 36 feet in length or longer. A rail 12 yards long, 80 pounds to the yard, weighs less than 1,000 pounds, and as it does not require to be handled a second time until after it has lain in the track a number of years, I think there can be but little objection to the increase in the weight of a rail with regard to the handling, and further, when such a rail is taken out of the track after long service, to have the battered ends sawed off, it would still make a good, long rail; far ahead of the cut steel rails which are used second hand nowadays.

The use of rails 12 yards long will take one-sixth of the joints out of track, which means one hundred miles of joints out of a track six hundred miles in length. This is no small item to

consider, saving as it does, 3,500 lbs. of angle bar splices to the mile, and 360 bolts, not including those bolts used to replace broken ones during the life of the rails. There are also 360 nut locks saved per mile besides the labor required to put on these fastenings and keep the track in repair at the joints. Taking all things into account I think a big saving could be effected annually in the cost of maintaining any ordinary main track, and the amount which could be saved in the first cost would be more than a million dollars in laying all the track of one of the larger railroads. Every trackman knows that the rail joint requires more labor than any other part of the track, and for this reason alone I would advocate making their number less. I think when considering the question, whether it is advisable to use a longer track rail, the only objection of any consequence that could be raised, would be on account of expansion and contraction, and the extremes of temperature of the locality in which the rails are to be laid will determine to a great extent what should be the limit to the length of the track rail if used with the present joint fastenings.

Investigation should be made to find out what is the greatest possible length of rail that may be used without injuriously affecting the track. I am of the opinion that a rail thirty-six feet long can be used with the joint fastenings now in use, in more than half of the United States, and

where the extremes of temperature are within a range of *one hundred degrees*, a much longer rail may be used; for instance, below the frost lines in the Southern States.

The theory of a continuous track with the joints welded by electricity, and the expansion and contraction controlled by split rails put in at intervalls along the track, has many objections, as have also some other new methods which were proposed as a means of lessening the number of joints in tracks, while but few, if any, objections of any consequence can be brought against the method advocated in this paper, and it seems to me the question can hardly be questioned that such a rail will make a smoother riding and a safer track than one thirty feet long, and effect a great saving in first cost, labor and maintenance.

PREMIUMS FOR TRACK MEM.

9. There are several railroad companies which have a premium system in force, and I believe that every railroad company in the United States should have some kind of a premium system, because with such a system, (if managed properly) it is an easy matter to make poor men good, and good men better. It must also be a great aid in keeping a much larger number of good men in the service, it stimulates a friendly rivalry amongst the men, and causes many of them to become more energetic and ingenious in

contriving means by which to accomplish better results.

Necessity is a great force to make men work, but it has not the same power to lead a man to put forth his best efforts that some marked recognition of his services has. The hope of reward often makes a man industrious and trustworthy, who would perhaps otherwise be lazy and careless of the company's interests.

Railroad officers should make their promotions in the track service as much as possible from among the men working under them on the same division of the road. Because the prospect of sure promotion as the reward for faithful service and ability, will bring out the best efforts of most men. Even where this policy is pursued the chances for the average trackman are none too many.

I do not favor any premium system which is not based on absolute fairness; any other would only cause jealousy, and be injurious both to the company and the employee. For instance, take a section of track where the conditions are such that a foreman in charge needs to make but little effort to keep it in better shape than the other sections along the road. He should not receive the highest premium. But when a foreman is in charge of a section of track which is very difficult to keep up to the required standard, and through his ingenuity and industry succeeds in improving this section better, in proportion to

his help and the surrounding circumstances, than the other foremen on the division, no matter whether his section was a mud or stone ballasted track, on either branch or main line, that foreman should receive the highest premium. It might be well when inspecting the track before making the award of premiums, to have the men from one division act as judges of another division; and in making the awards, the foreman whose track received the greatest number of points on line and gauge surface and level should always rank the highest.

I think that premiums offered in the track foreman's department should not bring into competition any more than the number of men working under one superintendent's or roadmaster's management, because as the number of competitors is increased the men's interest decreases (except when they are favorably located) and the chances for making a just and fair award becomes less in proportion.

There ought to be at least four premiums offered on each roadmaster's division; one of fifty dollars, of twenty-five dollars, one of fifteen dollars, and one of ten dollars. Such a distribution of the prizes would bring the men into competition nearer home and more on equal footing, and their chances of securing a prize would be greatly increased. The method of increasing the wages of track foremen in proportion to their ability and length of service, making a difference

of, say, ten dollars per month, between minimum and maximum wages paid to section foremen at the same grade of work, would be more expensive I believe than giving premiums, but it might accomplish the best results in some localities.

The adoption of either of these methods should accomplish good results on any railroad.

HINTS TO SECTION FOREMEN.

10. Track foreman should be respectful to his superior officers without being servile, and when talking or writing to them he should show a confidence in himself without making too much of an exhibition of self conceit or stubbornness, either of which will only be awarded with their ridicule or contempt. A man who is placed over other men should have a will power strong enough to control them and maintain his authority without being either abusive or profane. To bulldoze an inferior is not the way to either instruct him or gain his respect.

Foremen who can keep good men, and secure more men when wanted, are more valuable to a railroad company than those who frequently discharge men and who seldom have help when it is needed.

Try to gain the respect of your men and you will have faithful workers. To do this it is not necessary that you be too familiar with them.

If you have a man working for you who will not do the work as you instruct him, discharge him and get some man who will. But do not work along in a groove, and think you have learned it all, and if any of your men suggest something which you know to be an improvement do not be ashamed to adopt it.

Track foremen should learn the habit of studying out the best method of doing each piece of work on which they are engaged, and when practicable have the work planned out before hand. The mind can often do more than the hands.

A good track foreman will have a keen interest in his work, and be ambitious to show good results as well the last day he works for a company, as when he was first promoted from the shovel.

Foremen who are not prompt in executing the orders of the roadmaster, and who often do work in a way contrary to that in which they have been in-tructed, seldom hold a position long on any road. This kind of men, together with that class which frequent saloons and get drunk occasionally, constitute about nine-tenths of the section or track foremen who are discharged for cause. Roadmasters very seldom discharge a foreman for his want of knowlodge about some particular piece of work, and they are always willing to give information as to the best methods of doing the work when asked for it. When-

ever a track foreman begins to think his work is too hard and his pay is too small, or that the officers of the road are not using him right, he becomes careless and loses all interest in the work. That man should quit at once and go hunt a job in some other place where he might be better satisfied and appreciated. Every track foreman should make a continued effort to elevate his profession and make it respectable. Be sober, honest and industrious and you will be successful.

TRAIN YOURSELF.

11. The young man who works on track with pick and shovel, and his brother laborer in other departments of the railway service, should make some effort to improve themselves mentally, while working in subordinate positions, if they look beyond their present needs and have any ambition to be promoted.

The simple fact that a man has learned how to perform a certain duty as well as his superiors, does not make him their equal mentally, or fit him to take their places. He should have acquired an education during his service or before it, which would show to observers that he had improved with time in mind, manners and habits. Many old railroad men grumble when they see new men enter the service, and quickly climb the ladder of promotion, while they still re-

main in the same old rut. But such men are generally blind to the fact that the men so promoted are their superiors in intelligence and ability.

There are some cases, no doubt, where a personal preference or prejudice influences the selection of men, but such instances are becoming very rare now-a-days. The intelligent, practical man will always be selected to fill the higher positions on a railroad, and from whom can he as well be selected, as from the workers who have studied the details of the service, and are capable of improving on the work of others.

Even the uneducated track laborer may observe the methods of his superiors in the same line of work; he can devote a little time to study evenings, and by reading newspapers and books which give information on subjects connected with his work, he will soon acquire an education sufficient to fit him for something better. The fact that a man cannot attend a school does not put an education beyond his reach. A young workingman's intellect and ability to learn should be much stronger and greater than when he was a boy. Always remember that your promotion to a higher position and better wages will depend in a great measure on your intelligence and ability to earn it.

A man without an education sufficient to enable him to manage his business properly is like a saw blade without a handle, or a locomotive

disabled on one side. He is a cat's paw for the monkey, and like a stray goose may be plucked by every sharper with whom he comes in contact.

SECTION RECORD.

12. I would like to call the attention of trackmen generally, and especially section foremen, to the importance of keeping a record of everything connected with the piece of track in their charge. Every foreman should know the length of his section, the amount of straight and curve track, the degree of every curve, the different brands of steel or iron rail, how much of each and when laid. He should also know the number of cuts on his section and the amount of snow fence, if any, on each cut; the bridge and culvert numbers and highway or railroad crossiings, and the distance they are from his headquarters; and many other facts of importance which are very valuable to assist a man in organizing work, and making comparisons, also that he may be in a position to answer questions of his superior officers as to location of places and things without the necessity of making special examinations when the time cannot well be spared. The following example illustrates a simple form for condensing the information referred to, and is a handy way for foremen to write it out on the pocket memorandum.

SECTION NO. 10.

Length of Section..........6 miles, 1,000 feet.
" " north side track..........1,600 "
" " house track.............1,800 "
" " south track.............1,000 "

BRIDGE NO.	NO. OF BENTS.	LENGTH OF SPAN.	DISTANCE FROM STATION.
50	3	30 feet.	2 miles.
51	8	100 "	2½ "
52	Iron.	120 "	3¼ "

CULVERT NO.	BOX.	STONE.	IRON PIPE.	DISTANCE FROM STATION.
186	....	1	....	1½ miles.
187	....	......	1	1[illegible] "
188	1	......	....	2½ "

CUTS, LENGTH IN FEET.	HEIGHT ABOVE RAIL.	PANELS OF SNOW FENCE.	DISTANCE FROM STATION.
One 352	4 feet.	22	3 miles.
" 488	8 "	30½	3½ "
" 1260	9 "	89	4 "

STEEL RAIL, AMOUNT.	WHEN LAID	BRAND.	EXTENDS FROM STATION.
4 miles, 500 ft.	1886	N. C. R. M. Co.	West –
Iron. 2 miles,	....	....	From Steel to End of
500 feet.	1875	Crawshaw.	Section.

AVERAGE DAY'S WORK FOR ONE MAN.

13. The amounts of labor given below can each be performed by one good man in one day, and will serve to show comparatively the relation existing between the labor of one man, and that of a large gang of men, at any of the different kinds of work specified:

ONE MAN CAN

Lay to place on a grade one-eighth of a mile of ties;
Spike one-tenth of a mile of track laid on soft ties;

Spike one-fourteenth of a mile of track laid on hard ties;
Splice and bolt one-sixth of a mile of track;
Clean with a shovel one-eighth of a mile, average weeds;
Unload 10 cars of gravel;
Unload 8 cars of dirt;
Load upon cars eighteen to twenty-four yards of gravel;
Load upon cars twenty to twenty-five yards of dirt;
Load coal into buckets for engines, 15 to 20 tons;
Unload coal cars into shed, 25 to 30 tons;
Put in a dirt ballast track twenty new ties:
Put in a gravel ballast track fifteen new ties;
Put in a stone ballast track eight to ten new ties;
Do labor equal to ballasting sixty feet gravel track:
Do labor equal to ballasting thirty-five feet stone track.
Chop two cords four foot wood;
Make fifteen to twenty-five hard wood ties;
Make thirty-five to forty soft wood ties:
Sixty men can lay one mile of track in a day.

TRACK BOLTS.

14. The number of bolts in a 200 pound keg of track bolts, Hex. nuts $1\frac{3}{8} \times \frac{3}{4}$, is as follows.

SIZE OF BOLT.	NO. PER KEG.	NO OF BOLTS REQUIRED FOR ONE MILE OF TRACK.	
		4 BOLTS TO JOINT.	6 BOLTS TO JOINT.
$3\frac{1}{2} \times \frac{3}{4}$	240	6 Kegs.	$8\frac{3}{8}$ Kegs.
$3\frac{3}{4} \times \frac{3}{4}$	227	$6\frac{1}{8}$ Kegs.	$9\frac{1}{2}$ Kegs.
$4 \times \frac{3}{4}$	218	$6\frac{1}{2}$ Kegs.	$9\frac{2}{3}$ Kegs.

Bolts of the size here given are the ones now most generally in use on standard gauge railroads.

SPIKES.

15. Owing to the differences in the shape of the heads and the general form of the body of the spikes manufactured by the different companies who furnish railroad supplies, it is not possible to make a table which would show the correct number of spikes, of all sizes, per keg of 150 or 200 pounds weight. The spikes most commonly used to spike narrow gauge and standard gauge track are as follows:

TABLE.

SIZE	AVERAGE NO. PER KEG OF 200 LBS.	WEIGHT PER YARD OF RAILS USED.	NO. OF KEGS PER MILE
4 x 1/2	600	25	18
4 1/2 x 1/2	525	35	21
5 x 1/2	448	35 to 45	24
5 1/2 x 9/16	378	45 to 75	28

To ascertain the number of spikes in a keg, for any size of spike not mentioned in the table: divide the full weight of a keg of spikes, less the keg, by the weight of one spike, and the quotient will be the number of spikes contained in the keg.

NUMBER OF SPIKES.

16. A 200 pound keg contains on an average 378 spikes, $5\frac{1}{2}$ x 9-16.

The following table shows the number of ties, 30 foot rails, and feet of track that can be spiked in full, by different numbers of kegs of spikes, $5\frac{1}{2}$ x 9-16 inches.

TABLE.

No of Kegs $5\frac{1}{2}$x9-16.	No. of Ties.	30 Foot Rails.	Feet of Track.
One...........	$94\frac{1}{2}$	$6\frac{1}{3}$	190
Two..........	189	$12\frac{1}{2}$	380
Three.........	$283\frac{1}{2}$	18 13-16	570
Four..........	378	$25\frac{1}{2}$	760
Five..........	$472\frac{1}{2}$	$31\frac{1}{2}$	945
Six............	567	37 5-6	1135
Seven.........	$661\frac{1}{2}$	44 1-10	1330($\frac{1}{4}$m)
Fourteen......	1323	88 1-5	2640($\frac{1}{2}$m)
Twenty-eight...	2646	176 2-5	5280(1m)

There is no allowance made in the above table for broken spikes. The number is often large when laying new track, and foremen may find it necessary to order one or more kegs than the amount given in this table.

TONS OF RAILS REQUIRED FOR ONE MILE OF TRACK.

17. RULE.—To find the number of tons (2240) of rails to the mile. Divide the weight per yard by 7, and multiply the quotient by 11. Thus for 56 pound rail, 56 divided by seven equals 8, multiplied 11, equals 88 tons rails one mile of single track.

TABLE.

Weight of Rail Per Yard.	Tons Per Mile.	Weight of Rail Per Yard.	Tons Per Mile.
12 lbs	12 t, 920 lb	64 lbs	100 t, 1280 lb
14 lbs	22 t.	65 lbs	102 t, 320 lb
16 lbs	25 t, 320 lb	68 lbs	106 t, 1920 lb.
18 lbs	28 t, 640 lb	70 lbs	110 t.
20 lbs	31 t, 960 lb	72 lbs	113 t, 320 lb
22 lbs	34 t, 1280 lb	75 lbs	117 t, 1920 lb
25 lbs	39 t, 640 lb	76 lbs	119 t, 960 lb
26 lbs	40 t, 1920 lb	77 lbs	121 t.
27 lbs	42 t, 960 lb	78 lbs	122 t, 1280 lb
28 lbs	44 t,	79 lbs	124 t, 320 lb
30 lbs	47 t, 320 lb	80 lbs	125 t, 1600 lb
33 lbs	51 t, 1920 lb	81 lbs	127 t, 640 lb
35 lbs	55 t.	82 lbs	128 t, 1920 lb
40 lbs	62 t, 1920 lb	83 lbs	130 t, 960 lb
45 lbs	70 t, 1600 lb	84 lbs	132 t.
48 lbs	75 t, 960 lb	85 lbs	133 t, 1280 lb
50 lbs	78 t, 1280 lb	86 lbs	135 t, 320 lb
52 lbs	81 t, 1600 lb	87 lbs	136 t, 1600 lb
56 lbs	88 t.	88 lbs	138 t, 640 lb
57 lbs	89 t, 1280 lb	89 lbs	139 t, 1920 lb
60 lbs	94 t, 640 lb	90 lbs	141 t, 960 lb
62 lbs	97 t, 960 lb	91 lbs	143 t.

18. NUMBER OF CROSS TIES REQUIRED FOR EACH MILE OF TRACK.

TABLE.

DISTANCE FROM CENTRE TO CENTRE	NUMBER OF TIES.
1 foot 6 inches	3520
1 foot 9 inches	3017
2 feet	2640
2 feet 3 inches	2348
2 feet 6 inches	2113
2 feet 9 inches	1921
3 feet	1761

19. LENGTH OF RAIL AND NUMBER OF JOINTS, SPLICES, AND BOLTS FOR EACH MILE OF TRACK.

TABLE.

LENGTH OF RAIL.	NO. OF RAILS OR JOINTS.	NO. OF SPLICES.	NO. OF BOLTS 4 PER JOINT.
20 feet	528	1056	2112
21 feet	503	1006	2012
22 feet	480	960	1920
23 feet	459	918	1836
24 feet	440	880	1760
25 feet	422	844	1688
26 feet	406	812	1624
27 feet	391	782	1564
28 feet	377	754	1508
29 feet	364	728	1456
30 feet	352	704	1408
31 feet	340	680	1360
32 feet	330	660	1320
33 feet	320	640	1280
34 feet	310	620	1240
35 feet	302	604	1208
36 feet	292	584	1168

20. Table showing the number of pounds. of iron or steel per yard of rail, the weight of a 30 foot rail, and the number of tons of iron or steel required for one mile of track.

No. lbs. Per Yd. of Rail.	Weight of a 30 ft. Rail.	Tons of Iron or Steel per Mile of Track.		No. lbs Per Yd. of Rail	Weight of a 30 ft. Rail	Tons of Iron or Steel Per Mile of Track.	
		TONS.	LBS.			TONS.	LBS.
5	50	8	1600	69	690	121	880
30	300	52	1600	70	700	123	400
35	350	61	1200	71	710	124	1900
40	400	70	800	72	720	126	1440
45	450	79	400	73	730	128	960
50	500	88		74	740	130	480
51	510	89	1520	75	750	132	
52	520	91	1040	76	760	133	1520
53	530	93	560	77	770	135	1040
54	540	95	80	78	780	137	560
55	550	96	1600	79	790	139	80
56	560	98	1120	80	800	140	1600
57	570	100	640	81	810	142	1120
58	580	102	160	82	820	144	640
59	590	103	1680	83	830	146	1160
60	600	105	1200	84	840	147	1680
61	610	107	720	85	850	149	1200
62	620	109	640	86	860	151	720
63	630	110	1760	87	870	153	240
64	640	112	1280	88	880	154	1760
65	650	114	800	89	890	156	1280
66	660	116	820	90	900	158	800
67	670	117	1840	100	1000	176	
68	680	119	1365				

One pound more or less in weight per yard of rail makes a difference of one ton and 1,520 pounds in the weight per mile. The above table will enable any track foreman to see at a glance

the exact amount of iron or steel required per mile of track, if he knows the weight per yard of rail which he is using, or about to order for his division. For smaller amounts than one mile (if using 30 foot rails) multiply the number of rails required by the weight of rail given in second column, and divide by 2,000 pounds to reduce to tons.

21. TABLE

Showing the Number of Feet, Board Measure, contained in a Piece of Joist, Scantling or Timber of the Sizes Given.

SIZE IN INCHES.	LENGTH IN FEET OF JOISTS, SCANTLING AND TIMBER.											
	12	14	16	18	20	22	24	26	28	30	42	44	45
2x 4......	8	9	11	12	13	15	16	17	19	20	28	29	30
2x 6......	12	14	16	18	20	22	24	26	28	36	42	44	45
2x 8......	16	19	21	24	27	29	32	35	37	40	53	58	60
2x10......	20	23	27	30	33	37	40	43	47	50	70	74	75
2x12......	24	28	32	36	40	44	48	52	56	60	84	88	90
3x 4......	12	14	16	18	20	22	24	26	28	30	42	44	45
3x 6......	18	21	24	27	30	33	36	39	42	45	63	66	68
3x 8......	24	28	32	36	40	44	48	52	56	60	84	88	90
3x10......	30	35	40	45	50	55	60	65	70	75	105	110	113
3x12......	36	42	48	54	60	66	72	78	84	90	126	132	135
4x 4......	16	19	21	24	27	29	32	35	37	40	56	58	60
4x 6......	24	28	32	36	40	44	48	52	56	60	84	88	90
4x 8......	32	37	43	48	53	59	64	69	75	80	112	118	120
4x10......	40	47	53	60	67	73	80	87	93	100	140	146	150
4x12......	48	56	64	72	80	88	96	104	112	120	168	176	180
6x 6......	36	42	48	54	60	66	72	78	84	90	126	132	135
6x 8......	48	56	64	72	80	88	96	104	112	120	168	176	180
6x10......	60	70	80	90	100	110	120	130	140	150	210	220	225
6x12......	72	84	96	108	126	132	144	156	168	180	250	265	270
8x 8......	64	75	85	96	107	117	128	139	149	160	224	234	240
8x10......	80	93	107	120	133	147	160	173	187	200	280	294	300
8x12......	96	112	128	144	160	176	192	208	224	240	336	352	360
10x10......	100	117	133	150	167	183	200	217	233	250	350	366	375
10x12......	120	140	160	180	200	220	240	260	280	300	420	440	450
12x12......	144	168	192	216	240	264	288	312	336	360	504	528	500
12x14......	168	196	224	252	280	308	336	364	392	420	588	616	630
14x14	196	229	261	294	327	359	392	425	457	490	686	716	735

CUBIC MEASURE.

22. 1,728 cubic inches, one cubic foot; 27 cubic feet one yard.

A perch of masonry is 25 cubic feet.

A cord of masonry is generally figured at 100 cubic feet.

Three bushels of lime and one yard of sand will lay a cord of stone.

Two cubic feet of sound dry corn will make one bushel shelled corn.

There are twenty common bricks to a cubic foot of wall when laid.

Thickness of wall one brick average number per square foot = 14.

A cubic foot of ice weighs 58 pounds.

About 500 cubic feet of hay in a mow will weigh a ton.

422 cubic feet well settled hay weighs a ton.

7½ cubic yards of hay and about 12 cubic yards of dry clover measured from stacks will weigh a ton.

A cord of wood is 4 feet high, 4 feet wide and 8 feet long, or equal to 128 cubic feet.

SQUARE MEASURE.

23. 144 square inches 1 square foot, 9 square feet 1 square yard, 30¼ square yards 1 square rod, 40 square rods 1 rood, 40 roods 1 acre.

SURVEYOR'S MEASURE.

24. 7.92 inches 1 link, 25 links 1 rod, 4 rods 1 chain, 10 square chains or 160 square rods 1 acre, 640 acres 1 square mile.

LONG MEASURE.

25. 3 barleycorns 1 inch, 12 inches 1 foot, 3 feet 1 yard, 5½ yards 1 rod, 40 rods 1 furlong, 8 furlongs 1 mile.

DRY MEASURE.

2 pints make 1 quart, 8 quarts 1 peck, 4 pecks make one bushel.

LIQUID OR WINE MEASURE.

4 gills make 1 pint, 2 pints make one quart, 4 quarts make one gallon, 31½ gallons make one barrel, 2 barrels make one hogshead.

AVORDUPOIS WEIGHT.

16 drachms make one ounce, 16 ounces make one pound, 25 pounds make one quarter, 4 quarters make 100 weight, 2,000 pounds make 1 ton.

CIRCULAR MEASURE.

60 seconds make 1 minute, 60 minutes make one degree, 30 degress make one sign, 90 degrees make 1 quadrant, 4 quadrants or 360 degrees make 1 circle.

TIME MEASURE.

60 seconds make one minute, 60 minutes make one hour, 24 hours make 1 day, 7 days 1 week, 4 weeks 1 lunar month, 28, 29, 30, or 31 days make 1 calendar month, (30 days make one month in computing interest,) 52 weeks and 1 day, or 12 calendar months make one year.

26. SPEED TABLE FOR TRAINS.

Speed per Hour.	Time of Performing.				Speed per Hour.	Time of Performing.			
Miles.	½ Mile.		One Mile.		Miles.	½ Mile.		One Mile.	
	Min.	Sec.	Min.	Sec.		Min.	Sec.	Min.	Sec.
5	6	0	12	0	29	1	02	2	04
6	5	0	10	0	30	1	0	2	0
7	4	17	8	34	31	0	58	1	56
8	3	45	7	30	32	0	56	1	52
9	3	20	6	40	33	0	54	1	49
10	3	0	6	0	34	0	53	1	46
11	2	43	5	27	35	0	51	1	43
12	2	30	5	0	36	0	50	1	40
13	2	18	4	37	37	0	48	1	37
14	2	08	4	17	38	0	47	1	34
15	2	0	4	0	39	0	46	1	32
16	1	52	3	45	40	0	45	1	30
17	1	46	3	31	41	0	43	1	27
18	1	40	3	20	42	0	42	1	25
19	1	34	3	09	43	0	41	1	23
20	1	30	3	0	44	0	40	1	21
21	1	25	2	51	45	0	40	1	20
22	1	21	2	43	46	0	39	1	18
23	1	18	2	36	47	0	38	1	16
24	1	15	2	30	48	0	37 ½	1	15
25	1	12	2	24	49	0	36 ¾	1	13 ½
26	1	09	2	18	50	0	36	1	12
27	1	06	2	13	55	0	32 ¾	1	05 ½
28	1	04	2	08	60	0	30	1	0

The speed per hour which any train is making may be ascertained by simply counting the number of rail joints which the train passes over in 20 seconds of time. If the track rails are 30 feet long, the number of joints passed in 20 seconds, is always very nearly the speed in miles per hour.

27

Table of Wages on Bases of 10 Hours per Day.

RATES PER DAY OF 10 HOURS.	$1.00	$1.12½	$1.15	$1.20	$1.25	$1.30	$1.35	$1.37½	$1.40	$1.45	$1.50	$1.75	$2.00
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
1 Hour..........	.10	11¼	11½	.12	12½	.13	13½	13¾	.14	14½	.15	17½	.20
2 Hours.........	.20	.22	.23	.24	.25	.26	.27	.27	.28	.29	.30	.35	.40
2½ " or ¼ day.	.25	.28	.28	.30	.31	.32	.33	.34	.35	.36	.37	.43	.50
5 " or ½ day.	.50	.56	.57	.60	.62	.65	.67	.68	.70	.72	.75	.87	1.00
7½ " or ¾ "	.75	.84	.86	.90	.93	.97	1.01	1.03	1.05	1.08	1.12	1.31	1.50
1 Day..........	1.00	1.12	1.15	1.20	1.25	1.30	1.35	1.37	1.40	1.45	1.50	1.75	2.00
2 Days..........	2.00	2.25	2.30	2.40	2.50	2.60	2.70	2.75	2.80	2.90	3.00	3.50	4.00
3 "	3.00	3.37	3.45	3.60	3.75	3.90	4.05	4.12	4.20	4.35	4.50	5.25	6.00
4 "	4.00	4.50	4.60	4.80	5.00	5.20	5.40	5.50	5.60	5.80	6.00	7.00	8.00
5 "	5.00	5.62	5.75	6.00	6.25	6.50	6.75	6.87	7.00	7.25	7.50	8.75	10.00
6 "	6.00	6.75	6.90	7.20	7.50	7.80	8.10	8.25	8.40	8.70	9.00	10.50	12.00
7 "	7.00	7.87	8.05	8.40	8.75	9.10	9.45	9.62	9.80	10.15	10.50	12.25	14.00
8 "	8.00	9.00	9.20	6.60	10.00	10.40	10.80	11.00	11.20	21.60	12.00	14.00	16.00
9 "	9.00	10.12	10.35	10.80	11.25	11.70	12.15	12.37	12.60	13.05	13.50	15.75	18.00
10 "	10.00	11.25	11.50	12.00	12.50	13.00	13.50	13.75	14.00	15.50	15.00	17.50	20.00
11 "	11.00	12.37	12.65	13.20	13.75	14.30	14.85	15.12	15.40	16.95	16.50	19.25	22.00
12 "	12.00	13.50	13.80	14.40	15.00	15.60	16.20	16.50	16.80	18.40	18.00	21.00	24.00
13 "	13.00	14.62	14.95	15.60	16.25	16.90	17.55	17.87	18.20	19.85	19.50	22.75	26.00

Table of Wages on Bases of 10 Hours per Day.---Continued.

RATES PER DAY OF 10 HOURS.	$1.00	$1.12½	$1.15	$1.20	$1.25	$1.30	$1.35	$1.37½	$1.40	$1.45	$1.50	$1.75	$2.00
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
14 "	14.00	15.75	16.10	16.80	17.50	18.20	18.90	19.25	19.60	20.30	21.00	24.50	28.00
15 "	15.00	16.87	17.25	18.00	18.75	19.50	20.25	20.62	21.00	21.75	22.50	26.25	30.00
16 "	16.00	18.00	18.40	19.20	20.00	20.80	21.60	22.00	22.40	23.20	24.00	28.00	32.00
17 "	17.00	19.12	19.55	20.40	21.25	22.10	22.95	23.37	23.80	24.65	25.50	29.75	34.00
18 "	18.00	20.25	20.70	21.60	22.50	23.40	24.30	24.75	25.20	26.10	27.00	31.50	36.00
19 "	19.00	21.27	21.85	22.80	23.75	24.70	25.65	26.12	26.60	27.55	28.50	33.25	38.00
20 "	20.00	22.50	23.00	24.00	25.00	26.00	27.00	27.50	28.00	29.00	30.00	35.00	40.00
21 "	21.00	23.62	24.15	25.20	26.25	27.30	28.35	28.87	29.40	30.45	31.50	36.75	42.00
22 "	22.00	24.75	25.30	26.40	27.50	28.60	29.70	30.25	30.80	31.90	33.00	38.50	44.00
23 "	23.00	25.87	26.45	27.60	28.75	29.90	31.05	31.62	32.20	33.35	34.50	40.25	46.00
24 "	24.00	27.00	27.60	28.80	30.00	31.20	32.40	33.00	33.60	34.80	36.00	42.00	48.00
25 "	25.00	28.12	28.75	30.00	31.25	32.50	33.75	34.37	35.00	36.25	37.50	43.75	50.00
26 "	26.00	29.25	29.90	31.20	32.50	33.80	35.10	35.75	36.40	37.70	39.00	45.50	52.00
27 "	27.00	30.37	31.05	32.40	33.75	35.10	36.45	37.12	37.80	39.15	40.50	47.25	54.00
28 "	28.00	31.50	32.20	33.60	35.00	36.40	37.80	38.50	39.20	40.60	42.00	49.00	56.00
29 "	29.00	32.62	33.35	34.80	36.25	37.70	39.15	39.87	40.60	42.05	43.50	50.75	58.00
30 "	30.00	33.75	34.50	36.00	37.50	39.00	40.50	41.25	42.00	43.50	45.00	52.50	60.00
31 "	31.00	34.87	35.65	37.20	38.75	40.30	41.85	42.62	43.40	44.95	46.50	54.25	62.00

28. Table showing the Amount of Wages due for any Number of Days Work to 30 Days, from 1 cent to $2 per Day.

No. of Days.	1 C.	2 C.	3 C.	4 $	4 C.	$1.00 $	$1.00 CTS	$1.10 $	$1.10 CTS	$1.15 $	$1.15 CTS	$1.20 $	$1.20 CTS	$1.25 $	$1.25 CTS
¼ Day	¼	½	¾		1		25		27½		28¾		30		31¼
½ "	½	1	1½		2		50		55		57½		60		62½
1 "	1	2	3		4	1	00	1	10	1	15	1	20	1	25
2 "	2	4	6		8	2	00	2	20	2	30	2	40	2	50
3 "	3	6	9		12	3	00	3	30	3	45	3	60	3	75
4 "	4	8	12		16	4	00	4	40	4	60	4	80	5	00
5 "	5	10	15		20	5	00	5	50	5	75	6	00	6	25
6 "	6	12	18		24	6	00	6	60	6	90	7	20	7	50
7 "	9	14	21		28	7	00	7	70	8	05	8	40	8	75
8 "	8	16	24		32	8	00	8	80	9	20	9	60	10	00
9 "	9	18	27		36	9	00	9	90	10	35	10	80	11	25
10 "	10	20	30		40	10	00	11	00	11	50	12	00	12	50
11 "	11	22	33		44	11	00	12	10	12	65	13	20	13	75
12 "	12	24	36		48	12	00	13	20	13	80	14	40	15	00
13 "	13	26	39		52	13	00	14	30	14	95	15	60	16	25
14 "	14	28	42		56	14	00	15	40	16	10	16	80	17	50
15 "	15	30	45		60	15	00	16	50	17	25	18	00	18	75
16 "	16	32	48		64	16	00	17	60	18	40	19	20	20	00
17 "	17	34	51		68	17	00	18	70	19	55	20	40	21	25
18 "	18	36	54		72	18	00	19	80	20	70	21	60	22	50
19 "	19	38	57		76	19	00	20	90	21	85	22	80	23	75
20 "	20	40	60		80	20	00	22	00	23	00	24	00	25	00
21 "	21	42	63		84	21	00	23	10	24	15	25	20	26	25
22 "	22	44	66		88	22	00	24	20	25	30	26	40	27	50
23 "	23	46	69		92	23	00	25	30	26	45	27	60	28	75
24 "	24	48	72		96	24	00	26	40	27	60	28	80	30	00
25 "	25	50	75	1	00	25	00	27	50	28	75	30	00	31	25
26 "	26	52	78	1	04	26	00	28	60	29	90	31	20	32	50
27 "	27	54	81	1	08	27	00	29	70	31	05	32	40	33	75
28 "	28	56	84	1	12	28	00	30	80	32	20	33	60	35	00
29 "	29	58	87	1	16	29	00	31	90	33	35	34	80	36	25
30 "	30	60	90	1	20	30	00	33	00	34	50	36	00	37	50

No. of Days.	$1.30 $	$1.30 CTS	$1.35 $	$1.35 CTS	$1.40 $	$1.40 CTS	$1.45 $	$1.45 CTS	$1.50 $	$1.50 CTS	$1.55 $	$1.55 CTS	$1.60 $	$1.60 CTS	$1.65 $	$1.65 CTS
¼ Day		32½		33¾		35		36¼		37½		38¾		40		41¼
½ "		65		67½		70		72½		75		77½		80		82½
1 "	1	30	1	35	1	40	1	45	1	50	1	55	1	60	1	65
2 "	2	60	2	70	2	80	2	90	3	00	3	10	3	20	3	30
3 "	3	90	4	05	4	20	4	35	4	50	4	65	4	80	4	95
4 "	5	20	5	40	5	60	5	80	6	00	6	20	6	40	6	60
5 "	6	50	6	75	7	00	7	25	7	50	7	75	8	00	8	25
6 "	7	80	8	10	8	40	8	70	9	00	9	30	9	60	9	90
7 "	9	10	9	45	9	80	10	15	10	50	10	85	11	20	11	55
8 "	10	40	10	80	11	20	11	60	12	00	12	40	12	80	13	20
9 "	11	70	12	15	12	60	13	05	13	50	13	95	14	40	14	85
10 "	13	00	13	50	14	00	14	50	15	00	15	50	16	00	16	50
11 "	14	30	14	85	15	40	15	95	16	50	17	05	17	60	18	15
12 "	15	60	16	20	16	80	17	40	18	00	18	60	19	20	19	80
13 "	16	90	17	55	18	20	18	85	19	50	20	15	20	80	21	45
14 "	18	20	18	90	19	60	20	30	21	00	21	70	22	40	23	10
15 "	19	50	20	25	21	00	21	75	22	50	23	25	24	00	24	75
16 "	20	80	21	60	22	40	23	20	24	00	24	80	25	60	26	40
17 "	22	10	22	95	23	80	24	65	25	50	26	35	27	20	28	05
18 "	23	40	24	30	25	20	26	10	27	00	27	90	28	80	29	70
19 "	24	70	25	65	26	60	27	55	28	50	29	45	30	40	31	35
20 "	26	00	27	00	28	00	29	00	30	00	31	00	32	00	33	00
21 "	27	30	28	35	29	40	30	45	31	50	32	55	33	60	34	65
22 "	28	60	29	70	30	80	31	90	33	00	34	10	35	20	36	30
23 "	29	90	31	05	32	20	33	35	34	50	35	65	36	80	37	95
24 "	31	20	32	40	33	60	34	80	36	00	37	20	38	40	39	60
25 "	32	50	33	75	35	00	36	25	37	50	38	75	40	00	41	25
26 "	33	80	35	10	36	40	37	70	39	00	40	30	41	60	42	90
27 "	35	10	36	45	37	80	39	15	40	50	41	85	43	20	44	55
28 "	36	40	37	80	39	20	40	60	42	00	43	40	44	80	46	20
29 "	37	70	39	15	40	60	42	05	43	50	44	95	46	40	47	85
30 "	39	00	40	50	42	00	43	50	45	00	46	50	48	00	49	50

No. of Days.	$1.70 $	$1.70 CTS	$1.75 $	$1.75 CTS	$1.80 $	$1.80 CTS	$1.85 $	$1.85 CTS	$1.90 $	$1.90 CTS	$1.95 $	$1.95 CTS	$2.00 $	$2.00 CTS
¼ Day		42½		43¾		45		46¼		47½		48¾		50
½ "		85		87½		90		92½		95		97½	1	00
1 "	1	70	1	75	1	80	1	85	1	90	1	95	2	00
2 "	3	40	3	50	3	60	3	70	3	80	3	90	4	00
3 "	5	10	5	25	5	40	5	55	5	70	5	85	6	00
4 "	6	80	7	00	7	20	7	40	7	60	7	80	8	00
5 "	8	50	8	75	9	00	9	25	9	50	9	75	10	00
6 "	10	20	10	50	10	80	11	10	11	40	11	70	12	00
7 "	11	90	12	25	12	60	12	95	13	30	13	65	14	00
8 "	13	60	14	00	14	40	14	80	15	20	15	60	16	00
9 "	15	30	15	75	16	20	16	65	17	10	17	55	18	00
10 "	17	00	17	50	18	00	18	50	19	00	19	50	20	00
11 "	18	70	19	25	19	80	20	35	20	90	21	45	22	00
12 "	20	40	21	00	21	60	22	20	22	80	23	40	24	00
13 "	22	10	22	75	23	40	24	05	24	70	25	35	26	00
14 "	23	80	24	50	25	20	25	90	26	60	27	30	28	00
15 "	25	50	26	25	27	00	27	75	28	50	29	25	30	00
16 "	27	20	28	00	28	80	29	60	30	40	31	20	32	00
17 "	28	90	29	75	30	60	31	45	32	30	33	15	34	00
18 "	30	60	31	50	32	40	33	30	34	20	35	10	36	00
19 "	32	30	33	25	34	20	35	15	36	10	37	05	38	00
20 "	34	00	35	00	36	00	37	00	38	00	39	00	40	00
21 "	35	70	36	75	37	80	38	85	39	90	40	95	42	00
22 "	37	40	38	50	39	60	40	70	41	80	42	90	44	00
23 "	39	10	40	25	41	40	42	55	43	70	44	85	46	00
24 "	40	80	42	00	43	20	44	40	45	60	46	80	48	00
25 "	42	50	43	75	45	00	46	25	47	50	48	75	50	00
26 "	44	20	45	50	46	80	48	10	49	40	50	70	52	00
27 "	45	90	47	25	48	60	49	95	51	30	52	65	54	00
28 "	47	60	49	00	50	40	51	80	53	20	54	60	56	00
29 "	49	30	50	75	52	20	53	65	55	10	56	55	58	00
30 "	51	00	52	50	54	00	55	50	57	00	58	50	60	00

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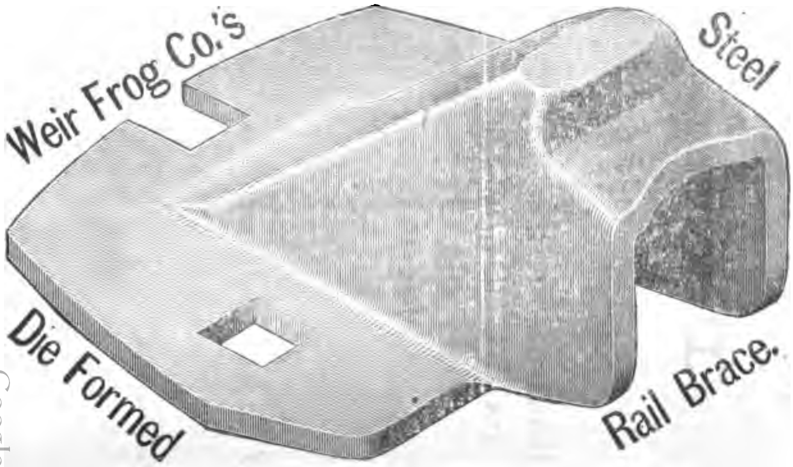

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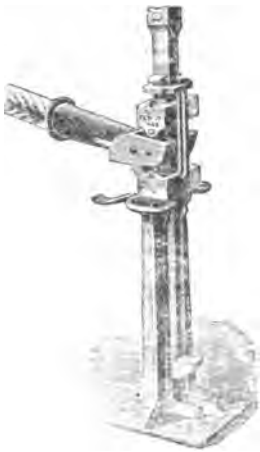

In explanation of the construction and operation of the STANFORD TRACK JACK, we show above cut. The weight is raised by the action of a Lever in connection with two Friction Clutches acting alternately. The Upper or Lifting Clutch serves to lift the load and the Lower Clutch to support it while the Lifting Clutch is lowered for a new lift. In case of wear, Packing Plates of Tin or Sheet Iron can be inserted by taking out Screw on top of Clutch Boxes--this will tighten the Clutches.

What Railroad Men Say Who Have Used the Jack.

The STANFORD TRACK JACK sent me for trial, I find to be an excellent Track Jack, far superior to any I have ever used. It is both quick and durable, and I can recommend it as a FIRST-CLASS JACK TOOL.

In regard to the STANFORD TRACK JACK, I can say, I am using them in yards and they give perfect satisfaction, and ARE THE BEST LEVER USED. On a section it saves the labor of one man.

I have thoroughly tested the different Track Jacks sent me for trial, and find the STANFORD to be by far the best I have ever used.

The STANFORD TRACK JACK has been thoroughly tested on this division since last spring by all gangs of men employed in raising and ballasting track, and I hear nothing but words of praise for them. I think they are the best Track Jack I ever saw or used.

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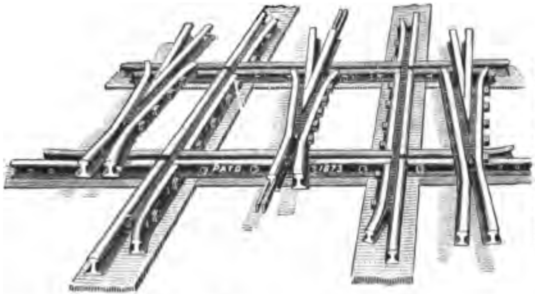

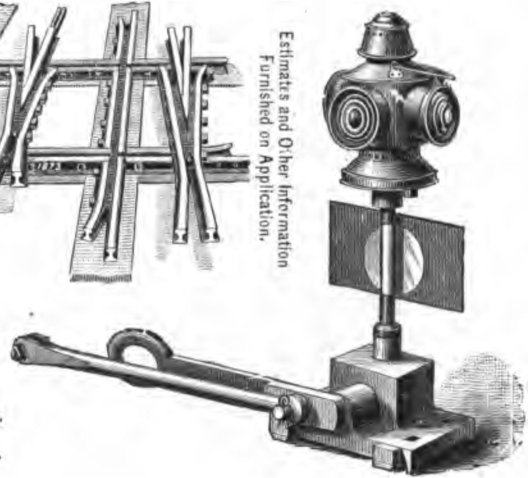

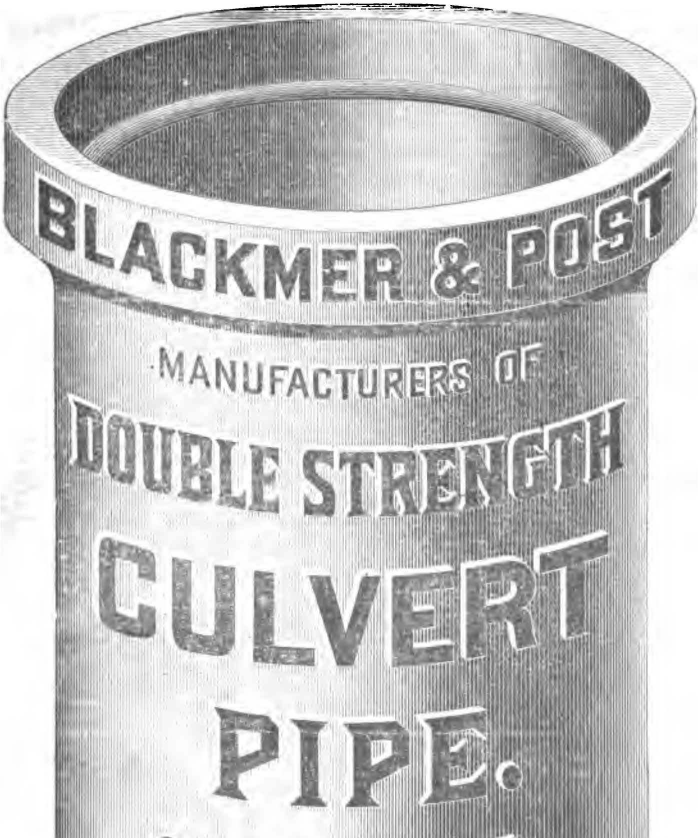

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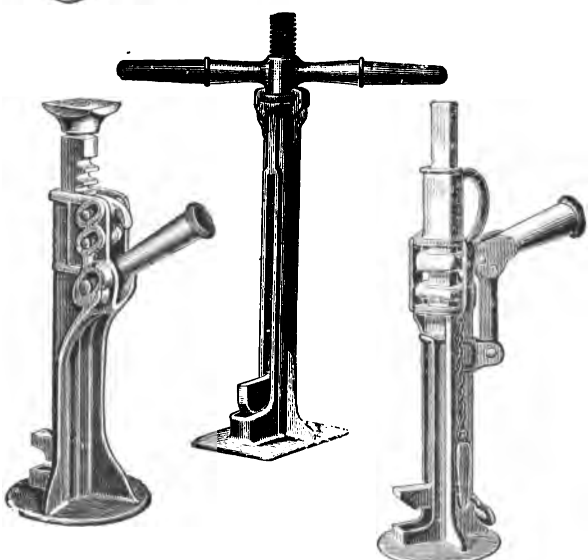

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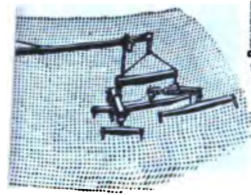

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